

A. E. Waller.

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# CHEMICAL & METALLURGICAL ENGINEERING

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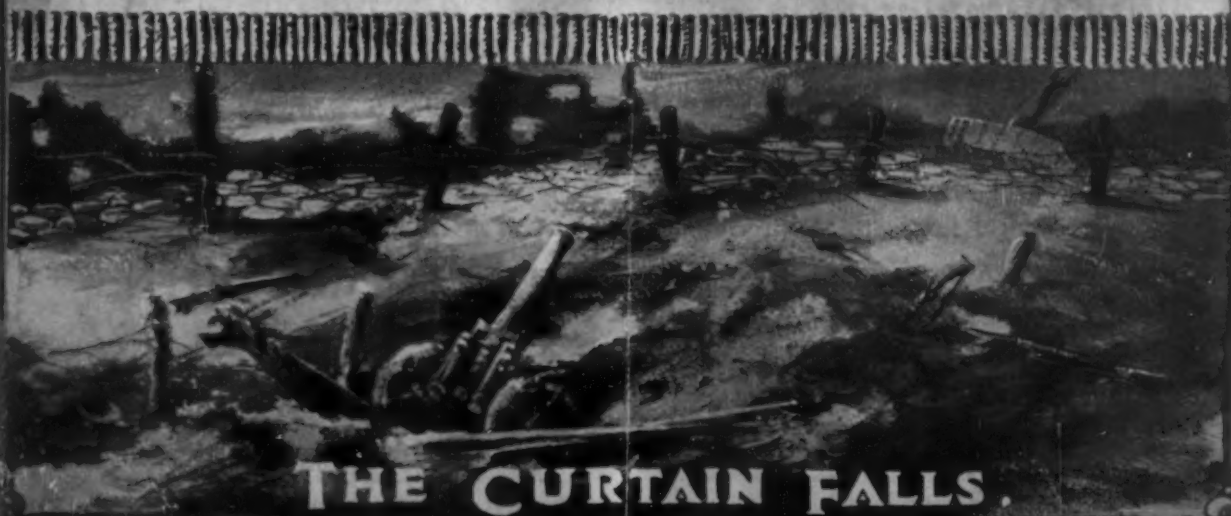
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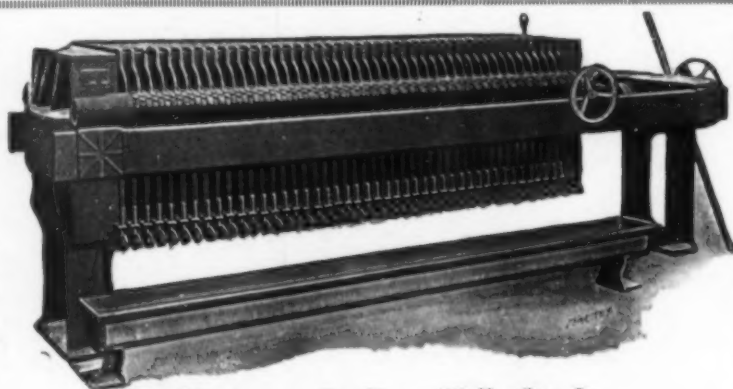
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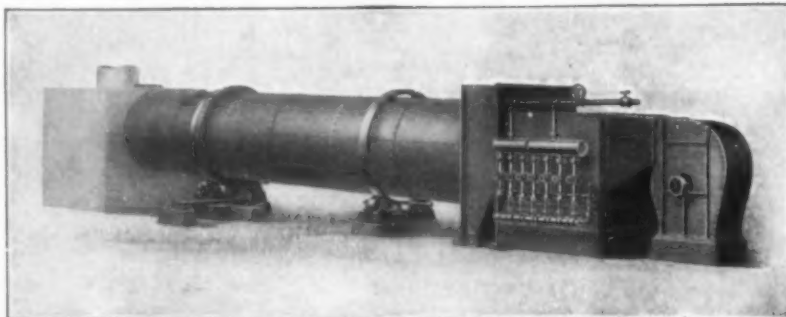
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# CHEMICAL & METALLURGICAL ENGINEERING

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### Stability of First

#### Importance for Industry

IN a recent address before the American Dyestuffs Manufacturers' Association, DR. F. W. TAUSSIG, Chairman of the United States Tariff Commission, laid down the important proposition: "Stability is of the first importance for any industry and at all times. Business can accommodate itself to almost any conditions, provided they be steadily maintained. This is true as regards prices and wages, banking and monetary systems, income taxes and taxes on business, and, not least, as regards tariff duties. It is quite as important, probably more important, that duties should be settled as that they should be high or low, well or ill adjusted. It is imperative to know on what basis business calculations may be made.

"Not only is this the case with regard to an individual business or a particular industry; it is true also as regards the prosperity of the country at large. Vacillation and uncertainty in tariff policy are probably more harmful than any extreme of high duties or of low duties. The good results which are obtainable through a protective system enure only if such a system is maintained consistently for a considerable period,—if time is given for the development of domestic industries, for growth under assured conditions, for the introduction of improved methods through long-continued experiment. And similarly, the good results which are obtainable under a policy of free trade are dependent upon its maintenance over a long period. They can come only through steady competition among foreign producers and domestic distributors, and the adjustment of export trade as well as of import trade to larger volume. A consistent policy followed for a considerable stretch of time is in either case essential for the attainment of the desired results.

"Let us now look at the situation which is to be expected in the immediate future in this country, and look at it frankly and openly. Let us not disguise the facts by vague generalities, by pleasant words, by rose-colored optimism. The truth, plainly stated, is that the outlook for stability is poor. Indeed, the prospects are of the slightest for anything in the nature of a settlement of the tariff. Consider the obvious facts of the political situation. We are at the beginning of the short session which closes the 65th Congress. In the 66th Congress, which will be in session from March 4, 1919, to March 4, 1921, there will be no unification of control and hence there can be no unification of policy. One party will have a majority in the House of Representatives; the Administration itself is of another party; the Senate will be very evenly divided. Not only this, but the traditional division of opinion and policy on the tariff

will not only be maintained, but is likely to be accentuated. The controversy on the protective policy will go on, and will be conducted on party lines. That controversy, it need hardly be said, is not between protection and free trade. The practical issue is one of degree,—whether there shall be high and strong protection all around, or limited and moderated protection. But the cleavage is clear. I will not undertake to say whether a permanent settlement will ever be reached in this country; but it would seem certain that not even such a provisional settlement as comes by the enactment of a general tariff law is within the bounds of probability for the next two or three years."

Clearly it is of primary importance for all American business men to meet the coming situation. The recent conference at Atlantic City, of which there is an account in this issue, and the Chicago meeting next month of the American Institute of Chemical Engineers are to serve as national clearing houses of thought. Stability in business depends on the business men getting together and taking united action.

### That Missing Page

#### From the Blue-back Speller

**A**N OLD "blue-back speller" still lingers in the minds of many of us as the staunch craft in which we were launched into this motley world of art and science. In the well-thumbed volume which was ours in those carefree days there was—how vividly we recall it!—a page torn out by some prior owner, probably as the instrument for some boyish class-room prank. Alas, years have passed, and with them the soiled blue-back with its missing page. Yet sometimes when sitting down to write a bit, and that trenchant word which polishes some epigrammatic phrase is laboriously evolved, we are compelled to pause for the spelling of it—should there be an "i" or an "a"? And then flashes suddenly into memory the missing page in the "blue-back," and it is beyond peradventure that this much-needed word once had there its proper place.

During the war hundreds of chemists and metallurgists were engaged in the most varied researches. But far too often they were confronted with a lack of knowledge concerning some very simple phenomenon, which, according to all the laws of common sense, should have been set down in black and white in that other primer which the earnest seekers after truth have written large in technical literature. It is on the missing page!

To be specific: The efficient use of manganese ferro-alloys is a matter of national interest, not only from the standpoint of economy in ferro-manganese but of more dependable metal—say gun-linings to be used overseas. Colonel W. P. BARBA of the Ordnance Department, in discussing the recent paper of Professor HOWE on "The Erosion of Guns," seriously questioned the practice of adding cold lumps of ferro-manganese to steel in the ladle, and pointed out that segregation was to be expected due to failure of the lumps to melt with sufficient rapidity to diffuse through the bath. If a change in steel-works' practice would help to safeguard the lives of our gunners "over there," we should have moved heaven and earth to put it into effect.

Before being able, however, to come to a decision as to the validity of the point raised, certain information of a very simple nature is needed. How long does it

take a piece of cold ferro-manganese the size of a walnut to melt when in contact with molten steel? If it is a matter of only thirty seconds then it would seem that preliminary melting of the ferro-alloy would be unnecessary, in fact undesirable on account of the power cost and the loss of at least some of the manganese. The question of chilling the bath does not seem to enter into the problem, as it obviously does in the case of spiegeleisen additions. If the melting, on the other hand, requires twenty minutes, it is another matter. Once the lump is melted, it would not seem to matter exactly at what part of the ladle it began to diffuse into the steel bath, since, in these circumstances, diffusion is a very rapid process, especially when aided by the strong convection currents existing in the ladle.

Inquiry among metallurgists of our acquaintance did not uncover any substantiated information as to the approximate length of time it takes such a lump of ferro-manganese to melt. Certainly it is a simple matter to determine experimentally. An electric furnace, a plum-bago crucible or two and a couple of hours, and we venture to say that this very important question could be solved. After this is done, it will be possible to discuss the disadvantages of adding cold ferro-manganese in the ladle more intelligently.

This is only an isolated case where technical progress is hampered by a lack of knowledge regarding fundamentals. Before writing any more essays in these fields we need to get out a revised, complete edition of the scientific "blue-back speller."

### The Smith-Howard Bill and Industry's Opportunity

**T**HE Smith-Howard Bill (S-3805 and HR-9686) provides that in each state or territory of the nation there be organized an engineering experiment station in an established university, college or engineering school within its boundaries. The purpose of these stations is to conduct research "in all branches of engineering, manufacturing and the industries, including chemistry, physics, electricity and other sciences." They are also to co-operate with agricultural experiment stations. They are to publish bulletins annually (at least), and these are to give the "results of said researches, investigations and experiments or reports of progress" in relation to the work in hand. The United States Government is to appropriate for each station \$15,000 the first year, \$20,000 the second, \$25,000 the third, \$30,000 the fourth and regularly \$30,000 each year thereafter. The legislature of each state shall designate the institution to engage in such study, subject to the approval of the Secretary of Commerce, who shall indicate lines of inquiry that seem important from a military or industrial standpoint. There is appropriated annually \$25,000 to establish and maintain in the Bureau of Standards a Department of College Research which shall keep all records and extend the facilities of the Bureau as far as is practicable. Provision is also made that the sum of money appropriated for research at any station shall not exceed that actually required for efficient and productive work.

The bill is supported by a committee of which President MacLaurin of the Massachusetts Institute of Technology is chairman, and we have received from Dr. W. R. Whitney of Schenectady an appeal in its favor.



Of course, under defective administration, the working of the proposed law could be resolved into a mere waste of money, but the time has arrived for us to exercise the quality of faith in our government. The party system under which it operates provides that active and even intense criticism be always maintained, and under this the chances are that a Cabinet member who used these funds for political purposes would soon find himself in hot water. The post of research professor in such institutions is not an easy job for a deserving Democrat or a regular Republican, unless he has the equipment both mental and temperamental to prosecute the work. We are not afraid of politics in this measure, and even if it should creep in, we have abundant faith in the instruments of publicity at hand to put an end to it.

Here is an opportunity for the industries of the country to become interested in and to benefit by the progress of science as it relates to each particular field. It will not take the place of individual or industrial research laboratories. We shall always have progressive men in industry who will keep ahead of the game. And the measure provides two greatly needed features: the opportunity to engage the activities of men gifted with the talent for research to their maximum usefulness for the general welfare, and it will drive into the minds of those industrial administrators who still sorely need it the enlightenment that the ways of stuff are not mystic or esoteric or past finding out, and that the mastery of particles unseen is not a hereditary gift, passed on along with secret formulæ or as the endowment of conjuring. Furthermore the co-operation of the Government in such research work with our educational institutions will undoubtedly be of much fundamental value to the curriculum, the student and industry.

### Steel Consumption and Investments

WITH the removal of Government control from iron and steel prices there is in prospect the form, if not the substance, of an open market. It is improbable that prices will decline at once, for the average producer has no incentive to cut. He has contract business on books, and the contract business can be worked out better if the market does not decline, while there is some demand at current prices and there is practically no latent demand that is awaiting a decline in the market to a certain determined level before it will take hold. How long prices will remain at their present level, or substantially that level, cannot of course be determined.

Perhaps there will be a time when iron and steel producers will be criticised for not reducing their prices, on the ground that development work is held back by iron and steel not being available at prices that would encourage buying. Circumstances are such as to develop a distorted view of the economics of the case. The cost of steel is a definite thing, while the cost of consuming steel is an indefinite thing. The one is quoted in market reports, the other is not. One can refer to current reports and see that structural shapes are priced at three cents a pound, and historical records can readily be consulted to show, for instance, that in occasional instances in the past they sold at a cent a

pound or a trifle more, also that the average quoted market price in the ten years before the war was just a trifle over a cent and a half a pound. Thus we have a cent a pound, a cent and a half a pound and three cents a pound, which is all very precise and concise, and also accurate, which is another matter, for accuracy is not a necessary attendant of precision and conciseness.

A large part of the steel made is placed in employment rather than consumed or used up. In other words it is an investment. To put steel into use as an investment always costs some money, and usually it costs a great deal. Now, the cost of steel is a matter of market reports and statistics, all clear and plain, but the cost of putting steel into employment is an altogether indefinite thing. It depends on the costs of various commodities and upon the cost of labor, not merely the hourly or daily rate of wages, but the cost of recruiting labor, the cost of supervising it and the hourly or daily work that is done by the labor in return for the amount paid. There are no market reports on this and no statistics easily consulted and covering all cases, like the market price of standard sizes of structural shapes.

By reason of this condition, the average observer, if he is not careful and conscientious in his habits of thought, is likely to be impressed by the cost of steel and to lose sight very largely of the cost of utilizing steel. To the investor it is all the same thing. The final cost of his investment, compared with what the cost would be six months, two years, five years, later, is all that he considers. The cost of the steel represents one group of items, the cost of all else another and very large group of items.

The average investment usually represents construction work, in which labor is employed. All wage rates have greatly advanced, but in the steel industry the advance in labor cost is a more definite and clear-cut thing than it is in the case of most construction work. The men at blast furnaces and in steel mills have definite duties to perform, and there has been no great variation in their performance. In the main, they simply receive more money per day. With construction work the variation is much greater, for there are two factors, the hourly or daily rate of wages and the amount of performance. The first had advanced, the second declined. There is room for a decrease in construction costs apart from a decrease in the nominal rates of wages paid. As to construction materials apart from steel, some have advanced more than steel, some less. Some present difficulties in securing deliveries apart from the price, and the progress of construction work requires unanimous consent of all the elements entering. All told, the cost of putting steel into employment is an item that has diverged widely from the former normal, and has shown puzzling trends. It is a more difficult item for the prospective investor to appraise, in relation to conditions that might obtain later, in case he delayed making his investment, than is the item of cost of steel. It may easily require much more time to produce a stable outlook for the cost of employing steel than to produce a stable outlook for the steel market itself. The steel industry, therefore, cannot force the situation by attempting to bargain with the investor. He has other and very important matters he must consider besides the cost of his steel.





plant. Extensive investigation has shown that this gold in a partially roasted ore is not readily amenable to either cyanide treatment or direct amalgamation. Blanketing was first introduced by Mr. J. M. Tippet at the Portland Mill in connection with the treatment of chlorination tailing. Each Chilean mill at the Golden Cycle is followed by two blanket concentrating tables, being merely apron-plates covered with a cotton bed-blanket. The cleanup is ground in arastra and grinding pan, the tails from the final small arastra being blanketed before passing into the main mill-feed, and the final concentrate is amalgamated in a barrel in strong cyanide solution.

Such delicately controlled roasting practice is liable to produce calcine of varying quality, especially just after one of the 5000-ton ore beds has been drained and before the new material is properly adjusted. If some insufficiently-roasted material should get into the system, solution of gold would be retarded by the deoxidizing power of the soluble sulphides, and rich residues would result. Rapid leaching of the sands is a precautionary measure attained by freeing them entirely from colloids and by loading the tanks in a semi-dry condition by conveyor and distributor. Desliming is done in a Dorr Bowl Classifier, consisting essentially of a shallow thickener, 13 ft. in diameter, set immediately above the lower compartment of a duplex drag-classifier. The slime overflowing the bowls will run 90 per cent through 200 mesh, the slime plant requiring a minimum of 88 per cent. Sulphides remaining in the slime are neutralized by immediate aeration in a 30 x 10-ft. mechanical-air continuous agitator, as is shown in the diagram, Fig. 1. In addition to these precautions, it is essential that a quick change of solution be made. On the sands this is done by the wash solution in the classifiers. A shallow, primary tray thickener receives the slime overflow from the bowl-classifier, and is of minimum volume so it may be cleared within half an hour.

#### Powered Coal for Igniting D. and L. Roasters

**A**N EXPERIMENTAL apparatus has been devised and used at the Midvale Smelter of the United States Smelting, Refining & Mining Co. for determining whether powdered coal could be substituted successfully for the more valuable fuel oil in igniting various lead-ore mixtures on a Dwight and Lloyd roaster. The results have been so gratifying that a permanent installation is now being installed in their roaster plant to serve all of the six machines now running. The permanent installation will contain a Raymond coal pulverizer, the product of which will be delivered by 4-in. screw conveyors to small steel hoppers at each furnace. The coal will then be burned by an apparatus very similar to that found so successful in the experimental work. It is expected that the results will be fully equal to the present; in fact, with some ore-mixtures coal gives a better cake than oil, since the oil flame apparently fuses the topmost surface, restricting the air-flow necessary for roasting and agglomerating the deeper layers. From 450 to 500 pounds of pulverized coal per day will suffice to operate one roaster, in place of 70 gallons of fuel oil.

As shown in Fig. 1, a small variable-speed motor

is belted to a reduction-gear driving at 30 to 40 rotations per minute a 2-in. worm passing through the bottom of the hopper containing pulverized coal. The coal delivered by the worm drops through a 1-in. pipe into a tee, where it meets a stream of compressed air at from 12 to 20 pounds and is then blown into the burner and ignites. The air receiver hides this part



FIG. 1. EXPERIMENTAL POWDERED COAL INSTALLATION

of the apparatus, which is diagrammed in the sketch, Fig. 2. The compressed air is taken from the regular service lines for pneumatic tools (90-lb. pressure) through an adjustable pressure-reducing valve. An air receiver, consisting of an ordinary domestic hot-water tank, is tapped on the line near this point to absorb pulsations in the air supply. The bushings at both

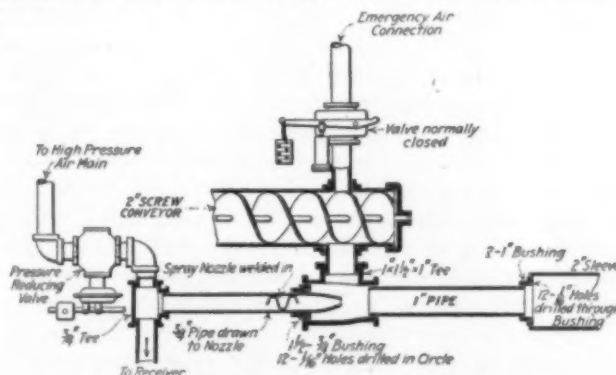


FIG. 2. SKETCH OF PIPING FOR EXPERIMENTAL PULVERIZED-COAL BURNER

mixing chamber and burner are drilled with a number of small holes so that auxiliary air may be drawn in as desirable. A helical screw is fixed in the line just before the mixing tee so that the whirling air supply may expand into a wide spray. In operation the mixture of air and coal is ignited by some burning waste until the muffle becomes hot enough to maintain the flame near the end of the 2-in. pipe sleeve.

This successful innovation was made by Mr. Howard Wright of the roasting department and Mr. William Erickson, engineer, working under the supervision of Mr. E. H. Hamilton, general superintendent.

Vernier Scales for reading decimal parts on graphic charts can readily be made on a tenth basis by applying the edge of a sheet of paper to the coördinates 10 and 4.58 and marking off the tens, and on a hundredth basis by using 100 and 1 as coördinates and marking off the intersections with the 100-lines. This is of use in accurately reading small scale charts.



## Atlantic City Meeting of the War Service Committees

Several Thousand Prominent Business Men Representing Three Hundred and Eighty Industries Hear Addresses on Reconstruction, Discuss and Pass Resolutions—Plan to Expand Scope of the Chamber of Commerce of the United States

THE meeting held under the auspices of the Chamber of Commerce of the United States Dec. 3 to 6 was a memorable occasion, and if we were asked to describe it we should say it was distinctly characterized by sanity, breadth of view and generosity. The plan was excellent, and the details, although rather jumbled at first, were brought into order by the second day. The general meetings held in the great hall of Young's Pier were attended to capacity. It is said that the place will seat 6000 persons comfortably, but there was not even standing room for all those who desired to attend these general meetings.

### ADDRESS OF PRESIDENT WHEELER

The addresses were remarkable contributions to the constructive thought of the day. Mr. Harry A. Wheeler, President of the Chamber of Commerce of the United States, made the first of these on Wednesday and treated more particularly of reconstruction, pointing out certain principles which must be applied if victory is to be secure in the fulfillment of those aims for which our men have fought. He pointed out how diplomacy needs the aid of men of business in its councils, more particularly in the problems of readjustment. Already, he said, whisperers, trouble-breeders and jugglers with words and reputations are turning their eyes to the unsavory diplomacy of the past and are intimating jealousies and jockeyings for position for which there should be no hearing at all among men of good will. He urged a more enlightened diplomacy which shall be free from secrecy and open to the judgment of public opinion.

He proposed an international plan for rationing raw materials so that nations which are not fortunate enough to possess them may be free to develop their science and their arts. He urged a live-and-let-live policy for the whole world. We must make the most of available tonnage and he insisted that if those nations which have the power to contribute to the reconstruction of countries and peoples stricken by the devastation of war do not bear these obligations in mind, then hardships and difficulties will be inordinately prolonged.

On Nov. 23 last he addressed a letter to the President asking if it would not be helpful if American industry should name a committee, informed in the basic industries of the country, to be present in France during the meetings of the Peace Conference and available for counsel in negotiations which bear directly upon commerce and industry. The President replied that frankly he did not know what message to contribute to the Atlantic City meeting, but that we should all take counsel and apply the wisest action to circumstances as they arise.

In its final resolutions the Conference concluded that a body of such competent men of large vision and generous impulses should be present. Other problems con-

sidered were subjects of extended debate at the various group meetings and found expression in the resolutions adopted at the final session.

### THE SECRETARY OF COMMERCE

On Wednesday Secretary Redfield made an earnest appeal for the application of science to industry. He gave a brief outline of the extraordinary activities of the Bureau of Standards and extended a cordial welcome to American business men to enter its open portals. He outlined the work of the Department of Commerce in the extension of foreign trade. The agents of the Government engaged in this service, he said, were required to be intimately familiar with the subjects which they are sent abroad to investigate and are required to have an easy reading, writing and speaking knowledge of the language of each country to which they are sent. He hoped that greater appropriations for an increase in the number of these useful agents of trade may become available.

### MR. CHARLES M. SCHWAB

Mr. Charles M. Schwab, Director General of the United States Emergency Fleet Corporation, first got his six or seven thousand auditors into good humor and then proceeded to discuss what he regarded as the most immediate problem before us in matters of reconstruction, which has to do with labor. We are all in the same boat, he declared; time was when capital tried to be the sole ruling factor in affairs, and labor has done the same thing. It cannot succeed. He recalled with no little humor the efforts made by trusts to control prices and profits without much consideration of the consumer, and he painted the consequences in lively colors. In regard to the Fleet Corporation, he said that when he undertook the direction of its affairs, he knew it would succeed if only American labor would back him up, and he was proud to say that American labor had done this very thing. Of course there had been troubles; it is impossible to gather in such a vast army of workers without having some whose vision of the general welfare is blinded by selfishness. But in the main they had been gloriously loyal to their country's call, and he could not put too much emphasis upon that fact. His only reason for leaving the post at the head of the Fleet Corporation was to return to the 170,000 employees under him at Bethlehem and elsewhere to provide for the best pay and the best conditions that may be brought about. He is a firm believer in organization within the works or the corporation and in the maximum of safeguarding every man's rights as well as his life and his liberty.

### PRESIDENT FARRELL OF THE U. S. STEEL CORPORATION

On Dec. 5 Mr. Farrell was unable to get to Atlantic City and his address was read in his absence. It had to do with foreign trade, and he said that it had grown



to such proportions that it was no longer necessary to convince manufacturers to enter it, but that our present task was rather to devise and guide. So devastating, however, has the war been that we cannot expect export trade to flourish unless we provide capital in those countries where we hope that our business may prosper. We must enter into their industrial life, engage in enterprises with them and thus create out of their resources the new wealth from which will come our pay. The advent of women into industry has been so great and so general that he doubted whether there would be as marked a shortage of industrial labor in the near future, even in war-devastated countries, as has been anticipated.

#### MR. JOHN D. ROCKEFELLER, JR.

Mr. John D. Rockefeller, Jr., spoke at the same meeting as that at which Mr. Farrell's paper was read, taking for his subject "Representation in Industry." He said that Capital, Management, Labor and the Community were the four parties to industry and that each was entitled to representation. Capital is represented by stockholders and is usually regarded as including management, but this is a serious error. The function of management is different and it is represented by technical skill and managerial experience. Labor is represented by the employees, but its contribution, unlike that of capital, is not detachable from the one making it, for it is his physical effort, his strength, his life. The community contributes the maintenance of law and order, the agencies of transportation and communication and many other services of prime importance. And the community consumes the product. Selfishness is not to be tolerated. Whether men work with brain or with brawn they have the same cravings, the same aspirations, the same hatreds and the same capacity for suffering and enjoyment. He insisted that we must organize a new order of things and provide some plan of co-operation which will insure to all concerned adequate representation, an opportunity to earn a fair wage under proper working and living conditions with such restrictions as to hours as will leave time for recreation and the development of the higher things of life as well as time to eat and to sleep.

He outlined a method which he favors which provides for the representation of labor and for appeals from decisions, and he gave a number of instances in which the plan is in successful operation. In conclusion he stated what he called his labor creed, which was included in a short form as the sense of the convention by a resolution unanimously adopted at the final meeting on Friday.

#### MR. PAUL M. WARBURG

Mr. Warburg, until lately a member of the Federal Reserve Board, made the last address on Friday. He recommended that to enable the United States to take its place as a foremost power in the commercial and financial world and to be fully equipped, the Capital Issues Committee and the War Finance Committee be continued. Government responsibility and influence in industry will tend to elevate business, but it presents the danger, he said, unless carefully guarded in form and scope, of corrupting and debauching the government itself. In the call for the continuation of these com-

mittees he added there is no challenge to England. He is certain England will retain her logical and traditional position as a world center for commerce and finance. Germany's position as an international banker will have to be considered as vacated for some time to come, but England, the United States and soon France as well will become partners rather than competitors; not partners in a close corporation to the exclusion of others, but rather in an establishment wide open to any respectable associate wishing to enter.

#### NINETY SPEECHES

As announced in our previous issues, the three hundred and eighty-odd war committees were grouped into thirty-six sections called related groups, which met in various places on the evening of Dec. 4. At each of these meetings there were addresses and here also resolutions were discussed which were brought in from the War Service Committees or offered from the floor. All resolutions passed were turned over to the corresponding unit of the ten major groups into which the thirty-six were consolidated and which met on the following (Thursday) afternoon at 2:30 and evening at 8 o'clock. Here again addresses were delivered, but our readers will understand why we cannot print these ninety addresses despite their leading importance to the industries involved. With apologies for our shortcomings in this respect we shall add a few notes from the addresses delivered before the committees on chemicals.

#### SECRETARY REDFIELD AGAIN

Chairman Henry Howard of Boston, who presided over the deliberations of Group 26, induced Secretary Redfield to add to his remarks of the same day in the Great Hall. Mr. Redfield's impression of the prospective status of the German chemical industry is that it will be far less favorable than before the war. That the country is evidently pretty well used up was indicated by the sore complaint that arose at the armistice demand for a certain number of locomotives and cars. The purpose was merely to restore the locomotives and cars taken from Belgium and France by the Germans. If the complaint is well founded that the act leaves them without the means of transportation, then the deduction is reasonable that the German railway system is used up as to equipment and that that of French and Belgian origin was used for replacement. He believes that the cost of production in Germany will increase more in proportion than it will here. Returning to the subject of scientific development in this country, he added the note that on the second day of President Wilson's first administration it was agreed between the President and himself that no man in the scientific service of the Government should be removed or appointed for political reasons, and that the agreement has been kept.

#### MR. W. D. HUNTINGTON

Mr. W. D. Huntington of the Davison Chemical Works, Baltimore, gave some information of the acid industry and its status. In 1914 we produced 4,200,000 tons of sulphuric acid of 50 deg. B. In 1917 this had increased to 8,300,000, and if the war had continued four or five months longer we should have been producing at the rate of 9,600,000 tons annually. The out-

look is that the only part of the country where any congestion of acid may occur will be in the Northeast. The rated capacity of plants outside of those owned by the Government is 6,200,000 tons, and in the South the fertilizer industry will absorb the output of the two great privately owned munition plants that are located there. The Government plants are closing. In the Northeast it may be necessary to reduce production to 70 per cent of capacity for awhile.

The great stocks of nitrate and sulphur at the Government plants should not be thrown upon the market, and he was glad to say that steps are being taken to avoid this very thing. The sulphur, for instance, will be taken in charge by the sulphur companies and distributed by them. The Government is anxious to dispose of stocks in such a manner as to do so to the greatest advantage and with the least hindrance to trade. In the discussion which followed Mr. Charles H. McDowell expressed the opinion that the consumption of acid will be at least 1,000,000 tons more than in 1914 and that an increase of 1,500,000 tons would be a closer guess.

#### MR. A. W. HAWKES

Mr. A. W. Hawkes, Vice President of the General Chemical Company, followed with the belief that increased consumption of sulphuric acid will take up the slack. The best way, in his opinion, is to play a waiting game for the next ninety days. In the meantime, he said, antiquated plants are being discontinued, and others, with the stress of extreme production removed, are being put into better operating condition.

#### DR. J. MERRITT MATTHEWS

Dr. J. Merritt Matthews read a paper on "Safeguarding the Dye Industry," in which he described the proposed British method of prohibiting the import of dyes made within the kingdom and requiring that a license be obtained from a special commission for every importation of foreign colors. The commission is to have very great power, for it is assumed that it will also grant licenses for importations to supply needs in excess of that which is made at home. Despite the many objections that may be raised against it, Dr. Matthews believes it to be the best method available to control the situation. If the licensing system should not be adopted, he recommended that both intermediates and dyes have equal protection to avoid the establishment of foreign houses to put through the last and simplest processes in making dyes from materials almost but not quite finished, which under the present law they could import under one-half the tax which the finished product pays.

#### DR. W. H. NICHOLS

Major Group 7 included all the junior groups related to it, and it met Thursday afternoon and evening under the chairmanship of Mr. Horace Bowker. The afternoon speaker was Dr. William H. Nichols, President of the American Chemical Society and Chairman of the Board of the General Chemical Co.

His address was an appeal to prevent the dye industry, which has taken such an effort to establish, to lapse, because it is so closely bound up with the development of chemistry and more particularly with chemical research and it contributes so much to that kind of pre-

paredness for war which is the best defense against it. He called special attention to the fact that the industry has not yet matured with us. To prove it he took the figures lately issued by the Tariff Commission giving the number of concerns engaged in making dyes and intermediates and the number of men engaged, and he divided the total men employed into the tonnage. Then he made a similar computation of the latest available



DR. WILLIAM H. NICHOLS

German data, and the showing was very unfavorable to the present American dye industry compared with that which formerly obtained in Germany. In other words, taking the entire industry of the country and including all engaged in it, the yields or finished product per man employed are still inadequate to meet German competition. This should involve no reflection upon American chemists. The war problem was to produce the things needed at any cost, and in many cases this was done. Now in organic syntheses there are often a number of ways to make a thing and it takes time and patience and chemical scholarship to develop the best method and then to nurse it along to maximum efficiency. This very development is in process now wherever sound chemical control is coupled with scholarly research, but results are not to be reached over night. Dr. Nichols had no definite measures to propose as to the specific means of conserving the industry, but he expressed his firm conviction that if our chemists have a fair chance for a reasonable time, without outside interference, we can lead the world in making dyes. He held to this without being frightened over the fact that the Swiss works are all unified, that the German works have joined in a Cartel, and that in England, France, Italy and Japan direct action has been taken by various steps such as prohibition of imports or guarantees of dividends to assure the maintenance of the industry in those countries.

At the evening session Mr. Charles H. McDowell of the Chemicals Division of the War Industries Board gave an interesting and illuminating outline of the problems which the Committee had to meet. He expressed the opinion that very cheap producer gas power



had been developed in Germany and he went into detail in regard to the nitrate situation from the beginning. Toluene production has increased from 500,000 gallons a year in 1914 to the rate of 24,000,000 gallons a year now. The alkali industry has increased in great measure, but he believed that the closing down of the Government electrolytic plants would avoid the production of excess alkali. The War Board, he said, tried to be constructive in its destruction and found many substitutes for materials that were required, a considerable number of which have entered into permanent use. The oxygen output has increased 1400 per cent since 1914 and 92 per cent of the whole is distilled from liquid air. He gave a long list of contributions made by the Mellon Institute of Industrial Research at Pittsburgh to the War Board and he urged upon industry the increase of technically trained men in its personnel. In regard to potash he doubted if Germany will be able to produce as cheaply as before the war, and he regarded as fair possibilities the outlook for about 30,000 tons from blast furnaces and 50,000 tons from the cement industry (on a  $K_2O$  basis) in this country under normal conditions. The cost at Searles Lake cannot be determined until larger quantities are produced, and the Georgia shales, containing 6 to 8 per cent of  $K_2O$ , he believed also to be a promising source of supply. In conclusion he noted the greatly increased team work throughout chemical industry as a result of the common experience of its many leaders who have given their time to the War Industries Board.

#### FEW FREAK RESOLUTIONS OFFERED

It stands to reason that in such a vast assemblage of men, all sorts and kinds of resolutions should be proposed. They always are, and they were this time. Sometimes the myopics (who constitute the short-sighted brotherhood) would line up at the back of the room at group meetings and vote through resolutions that had no place there,—and sometimes they failed in the attempt. There were some rather amusing incidents in this connection. The laundry owners, for instance, undertook to have it declared to be in the interest of the general welfare that articles washed for the retail trade should not be deliverable until four days after the pick-up. The motion was lost. The surgical instrument makers, on the other hand, firm in the faith that all things should work together for their good, managed to put through a demand at a group meeting that the United States Government should not dispose of any surgical instruments now in its possession until they become obsolete, "in order to be at all times prepared for war." There were, however, surprisingly few efforts of this sort, and excellent provision was made for them. After matters had been threshed over first at the related group meetings and again at the major group meetings, all resolutions were sent to the Clearance Committee, which worked all night, referred all piffle and unbaked ideas back to the Executive Committee of the Chamber of Commerce and by their supremely able drafting of consolidated ideas, presented those which follow in substance at the general meeting which closed the conference on Friday.

All of their proposals were adopted with nearly complete unanimity. Lack of space makes certain abridgements necessary.

#### The Resolutions Adopted

**Cancellation of War Contracts:**—It is in the public interest that all war orders placed by any contracting agency of the Government and accepted in good faith, whether formally and regularly executed or not, should, upon cancellation by such contracting agency, be promptly and equitably adjusted and satisfied as if every formality had been observed, and when so adjusted the amount ascertained to be due by the Government should be promptly paid to the end that these funds may be utilized by the industries of the country to speed their transition from a war to a peace basis.

If it should be ascertained that legislation is necessary or desirable to accomplish this end, Congress should forthwith enact such legislation.

Officials dealing with questions of adjustment on account of war orders must necessarily be familiar with all the conditions affecting the order. It will greatly promote expedition and the interests of both the Government and private enterprise for the officials who made the contracts to remain in the Government service to participate in the readjustments.

**Surplus Government Supplies:**—Under date of Nov. 29, 1918, the Secretary of War issued a public statement, i.e., "To prevent too violent dislocation of industry from the standpoint of both employee and employer, accumulation by the War Department of either raw material or finished product will be distributed when and where liquidation of such supplies will least interfere with the return of industry to a normal condition." Such action would seem to insure the stability of the industries affected, which fully appreciate this liberal position.

Therefore the War Service Committee of American Industries hereby tender to the War Department their services for their respective industries for the purpose of advising with and assisting the War Department in the disposition of such materials.

**Removal of Restrictions of Industry:**—It is in the public interest that all war regulations of industry should be revoked and all war restrictions on industry should be removed as speedily as practicable, save such industries as are engaged in the production, preparation or distribution of foods, feeds and fuel, and such last named group of industries should be freed from war regulations and restrictions as early as consistent with the welfare of this nation and of the Allies.

**Pivotal Industries:**—Conditions brought upon us by the European war at its beginning, as well as our national necessities after we entered the war, made it of the highest importance that a number of industries should at once be developed in the United States. Large investments, both of capital and skill, have since been placed in these enterprises. Upon the production of some of them, relatively small in themselves, the continuation of some of our largest industries has depended. Some of the recently developed industries have national importance in fields much broader than the markets of their products; for they may serve, for example, to promote scientific research, which will add to national efficiency, resources and wealth in many distinct ways.

It becomes essential, therefore, that the Government should at once proceed to ascertain the industries which have been developed during the European war and ascertain those the maintenance of which are indispensable for the safety of our industrial structure and our military establishment.

When these pivotal industries have been ascertained, means suitable in view of their nature and situations should at once be provided for their encouragement and preservation.

**Industrial Co-operation:**—The war has demonstrated that through industrial co-operation great economies may be achieved, waste eliminated and efficiency increased. The nation should not forget, but rather should capitalize these lessons by adapting effective war practices to peace conditions through permitting reasonable co-operation between units of industry under appropriate Federal supervision. It is in the public interest that reasonable trade agreements



should be entered into, but the failure of the Government to either clearly define the dividing line between those agreements which are and those who are not in unreasonable restraint of commerce, or to provide an agency to speak for it on application of those proposing to enter into such agreement, in effect restricts wholesome co-operation and deprives both industry and the general public of its benefits. The conditions incident to the period of readjustment render it imperative that all obstacles to reasonable co-operation be immediately removed through appropriate legislation.

**Federal Trade Commission:**—The Federal Trade Commission was advocated by the President and was created as an agency to make the administrations of our trust legislation explicit and intelligible, and to provide "the advice, the definite guidance and information" which business enterprises require. The normal importance of the Commission's task is now tremendously increased by the imperative need for whole-hearted and systematic co-operation between the Government and industry especially during the readjustment period and suggests the desirability of the two existing vacancies in the Commission's membership being promptly filled with able men of broad business experience and clear vision prepared to assist actively in discharging these tasks along constructive lines.

**Industrial Relations:**—The Convention heartily indorses in letter and spirit the principles of the industrial creed so clearly and forcibly stated in the paper read to it Thursday morning by Mr. John D. Rockefeller, Jr., and urges upon all units of industry where they may not now be employed the application of such principles.

Without approving or rejecting his particular plan or machinery, the principles advanced by Mr. Rockefeller are as follows:

1. Labor and capital are partners, not enemies; their interests are common interests, not opposed, and neither can attain the fullest measure of prosperity at the expense of the other, but only in association with the other.

2. The purpose of industry is quite as much to advance social well-being as material well-being and in the pursuit of that purpose the interests of the community should be carefully considered, the well-being of the employees as respects living and working conditions should be fully guarded, management should be adequately recognized and capital should be justly compensated, and failure in any of these particulars means loss to all.

3. Every man is entitled to an opportunity to earn a living, to fair wages, to reasonable hours of work and proper working conditions, to a decent home, to the opportunity to play, to learn, to worship, and to love, as well as to toil, and the responsibility rests as heavily upon industry as upon government or society to see that these conditions and opportunities prevail.

4. Industry, efficiency and initiative, wherever found, should be encouraged and adequately rewarded, and indolence, indifference and restriction of production should be discountenanced.

5. The provision of adequate means for uncovering grievances and promptly adjusting them is of fundamental importance to the successful conduct of industry.

6. The most potent measure in bringing about industrial harmony and prosperity is adequate representation of the parties in interest; existing forms of representation should be carefully studied and availed of in so far as they may be found to have merit and be adaptable to the peculiar conditions in the various industries.

7. The application of right principles never fails to affect right relations; the letter killeth and the spirit maketh alive; forms are wholly secondary, while attitude and spirit are all important, and only as the parties in industry are animated by the spirit of fair play, justice to all and brotherhood will any plans which they may mutually work out succeed.

8. That man renders the greatest social service who so co-operates in the organization of industry as to afford to the largest number of men the greatest opportunity for self-development and the enjoyment by every man of those benefits which his own work adds to the wealth of civilization.

**Relocation of Labor:**—The conversion of the industry of

the country from a peace basis to a war basis involved a general and important dislocation of labor. This movement was gradual. The end of the war involves a much more rapid change in industry; while there will be a great demand for labor to meet the foreign and domestic requirements, there may be for a time in special places a temporary condition of unemployment.

In the new relations of industry to labor we conceive it to be incumbent upon the community affected promptly to meet such conditions.

**Public Works:**—The development of public works of every sort, as recommended by the President, should promptly be resumed, in order that opportunities of employment may be created for unskilled labor.

**Taxation:**—The cessation of hostilities brings to business interests a feeling of deep concern in the matter of taxation. The problems of readjustment are made more difficult through inequalities in the present law.

We believe, therefore, that in the consideration of amendments to the present act, or the passage of new revenue legislation, the Congress should give most careful consideration to the views expressed by organizations of commerce and industry. Ability to pay, inventory values and proper reserves, together with careful survey of the amount of revenue required under the new conditions, are matters of vital importance to business interests of the nation during this readjustment period.

**Inventories:**—We urge that Congress should give careful consideration to the grave menace now facing all industry due to the fact that both raw materials and finished goods are carried in full measure to meet the extraordinary requirements of the Government and of the people, and that in large part the stocks have been acquired at abnormal cost and are therefore carried into inventories at inflated values, thereby showing apparent profits which have not been realized, and which probably will never be fully realized. These are largely bookkeeping or "paper" profits, and should not be used as a basis for taxation.

We therefore recommend that any tax law shall provide that during present conditions the taxpayer shall be allowed to make a deduction from his apparent profit by way of a reserve for subsequent shrinkage in merchandise values.

We believe that the interests of the Government can be protected against abuse of this privilege by the fixing of a maximum percentage of deduction to be allowed and by the use of proper methods of inspection and appraisal.

**Water Powers:**—Industrial activity is dependent upon the available supply of power. A bill which would affect the development of hydro-electric power upon waterways and lands which are subject to Federal jurisdiction is now before a committee of conference between the two houses of Congress. It is important in the public interest that Federal legislation on this subject should be enacted without further delay. We accordingly urge that the conference committee arrive at an acceptable form of legislation in season for enactment at this session of Congress.

**European Commission:**—The business men of the United States, having devoted their energies and resources toward the winning of the war, regardless of sacrifices or burdens, in support of the principles for which this country fought, appreciate the necessity of continuance of unremitting effort in order that the world may be restored to normal conditions as quickly as possible and the blessings of peace brought to all peoples.

In the accomplishment of these results the highest efficiency of the great commercial and industrial powers of our own country and that of the Allied nations will be developed only through co-operative effort and common counsel.

In order, therefore, to contribute to the fullest toward the prompt solution of the problem presented, the Chamber of Commerce of the United States is requested to enlist the co-operation of national bodies devoted to the extension and promotion of American commerce and particularly foreign trade, in the appointment of a commission representative of American business, which shall proceed without delay to Europe and establish machinery for the following purposes:

1. To study at first hand the reconstruction needs of European countries in conjunction with business men of these nations in order to advise the business men of the

United States as to how they may be most helpful in meeting the necessities of Europe and caring for the interests of American industry and commerce.

2. To be available to the peace delegates of the United States for any needed information which they may be able to present or for any other aid which may be given by the business men of the United States through the medium of such a commission.

The Chamber of Commerce of the United States also is requested to appoint members of the Commission to represent the business men of the United States at the forthcoming meeting of the Permanent Committees of the International Congress of Chambers of Commerce.

**Markets for Foreign Trade:**—We strongly urge upon our Government the vital necessity of encouraging and developing our foreign trade through all appropriate means possible, in order that the production of industry may afford employment to wage earners and prosperity to the nation.

**South American Relations:**—It has long been the policy of this nation to cultivate relations of close sympathy with the nations of the Western Hemisphere as expressed in the Monroe Doctrine. We believe that these relations should be supplemented and strengthened by a vigorous development of our commercial and financial associations with our neighbors of North and South America.

The Government's control of shipping should be brought to the accomplishment of this purpose as soon as it is consistent with other urgent needs, and the work of the Pan-American Union should be continued and broadened in scope.

**Property Rights in Mexico:**—By provisions in a constitution adopted while much of the country was engaged in civil strife, and through subsequent legislation, Mexican authorities have threatened rights acquired by Americans in good faith, especially in minerals, including petroleum. Against threatened confiscation the American Government made formal protests. The attitude taken by the American Government is heartily commended as in accordance with obvious justice.

**Education for Foreign Commerce:**—In the larger opportunities which are to be opened to American business men to play a part in the international commerce of the world the need will be felt for more men who are trained to a knowledge and understanding of the language, the business methods and the habits of thought of foreign lands. Complete success can only come to those who succeed in putting themselves into full accord and sympathy with the peoples with whom they are to deal.

We urge upon our industrials that they take steps to provide opportunities to young men to obtain an education in the practices of overseas commerce and finance and in the practical use of foreign languages.

We call the attention of the various departments of Government and to educators to the importance of this matter and ask that special efforts be made to supplement the valuable work already done and to open up every facility to the furtherance of a successful prosecution of this educational work.

**Forest Products Laboratories:**—The Forest Products Laboratories, of the United States Forest Service, have rendered valuable service through scientific investigation of the physical properties of American woods and their adaptability for structural, industrial and ornamental usage. It is of great importance to American industry that the Government should extend and adequately maintain the work of the Forest Products Laboratories.

**Cost Accounting:**—It is the sense of this Convention that uniform cost accounting should be adopted by industries.

Other resolutions favor the return of railways to their owners under proper conditions, oppose Government operation of telephones, telegraphs and cables, favor the development of the merchant marine, the amplification of port facilities, the proper study by Congress of public utilities, the generous provision of raw materials to our Allies for reconstruction, the extension of scope of the Council and Executive Committee of the Chamber of Commerce, and resolutions of appreciation of the work of the speakers, the committees and the Associated Business Papers for their daily newspaper.

## Institute of Chemical Engineers Chicago, Jan. 15-18

THE secretary of the Institute, Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N. Y., announces this tentative program for the winter meeting:

"What Is Going to Be Done by the Tariff Commission on the Question Relative to the Chemical Industry?" Dr. Grinnell Jones, U. S. Tariff Commission, Washington, D. C.

"United States Dye Industry," Dr. L. J. Matos and Dr. L. C. Jones, National Aniline Co., New York.

"Reinforced Concrete Tanks for Storing Ammoniacal Liquors," Dr. F. W. Frerichs, St. Louis, Mo.

"Reconstruction Aspects of Some Chemical Industries in the United States," Dr. Edward Gudeman, Chicago, Ill.

"Some Wild Engineering," Dr. David Wesson, Montclair, N. J.

Excursions will be made to the plants of the Corn Products Co., Argo, Ill., Lindsay Light Co. and Underwriters Laboratories in Chicago, Standard Oil Co., Whiting, Ind., and the Newport Hydrocarbon Co., Milwaukee, Wis.

The following letter has been sent to the chemical manufacturers of the United States:

"GENTLEMEN:—On Jan. 15 to 18, 1919, the annual meeting of the American Institute of Chemical Engineers will take place in Chicago. The chemical manufacturers of the United States are invited to send representatives to discuss the subject of the maintenance and preservation of our chemical industries.

"There are some who believe that a high protective tariff is all that is necessary to preserve the chemical industries. There are others who believe that only the newer chemical industries should be fostered, but it is the belief of your committee that the chemical industry of the United States must be carefully assisted not through any one particular means but through various methods which your committee briefly outlines.

"It is impossible to forecast the future, but if Germany fosters or otherwise subsidizes its chemical industries by means of specially low freight rates and transportation facilities, or if other countries pursue such a policy, the American chemical industries will be at a great disadvantage as far as export trade is concerned.

"Of course it is not to be presumed that the chemical industries will ask governmental assistance in those things which the chemical industries are competent to take care of themselves. This phase should also be presented.

"In 1919 a large amount of shipping will leave these ports filled with the necessities of life, such as food, agricultural implements and metals, and in preference to coming back in ballast, they may take freight at such low rates, and Germany may be willing to sell the materials it has on hand at such ruinous figures in order to obtain real money, that for a time paralysis of our industries may ensue.

"Another condition that always confronts manufacturers is unnecessary and undue competition, and our laws prevent co-operation excepting in cases of export. These are only a few of the conditions which must be manfully met and solved, and at the January meeting of the Institute the fullest discussion is invited, and the aid of our congress will be invoked.

"Will you be good enough to signify to the Secretary whether you will send a representative to attend this meeting. Respectfully submitted,

L. H. Baekeland,  
Maximilian Toch,

"G. W. THOMPSON,  
"President."

Chairman, Committee of Maintenance and Protection of Our Chemical Industries.



## Aluminium-Manufacturing Processes Used in Europe\*

Historical Review of Researches and Commercial Developments—Refining of Raw Materials—Description of Bauxites Used and Processes for Obtaining Pure Alumina—Manufacture, Consumption and Requirements for Electrodes—Information About Operating

BY O. NISSEN

IN 1811 Sir Humphry Davy produced an alloy of iron and aluminium by using an iron bar as the cathode. Thirteen years afterward Oersted is said to have produced the metal by heating aluminium chloride with potassium amalgam. Wohler in 1827 succeeded in producing it simply by reducing aluminium chloride with metallic potassium. As the materials were not pure and on account of the volatility of the chloride, the reaction was carried out at a low temperature. Up to 1845 Wohler had been able to produce only small particles of the metal, about the size of a pinhead. In 1854 Bunsen obtained aluminium for the first time by the electrolysis of aluminium-sodium chlorides, but electrolytic processes could not be of any practical importance at that time on account of the non-existence of large sources of electric current. Henry Sainte-Claire Deville developed the chemical reduction process after 1854 and with the help of Napoleon III a factory was built at Javelle. A few bars of aluminium were exhibited at the Paris Exposition in 1855 which attracted a great deal of attention. Deville conducted aluminium chloride vapor over incandescent potassium and had purer materials than Wohler. In place of potassium, Deville also used the cheaper sodium, and later he worked with aluminium-sodium chloride, which is less hygroscopic and more stable than aluminium chloride.

When in 1854 cryolite, the double fluoride of aluminium and sodium, was brought for the first time from Greenland to Europe, Dr. H. Percy produced aluminium from it by reduction with metallic sodium. At the same time and independently, H. Rose made the same experiment, and in 1855 he was the first one to produce aluminium by electrolysis of cryolite, when he was endeavoring to electroplate other metals with aluminium. Rose also used synthetic cryolite, and he reported: "This synthetic cryolite, as well as the natural, gives aluminium when reduced with sodium. Aluminium is also produced under the influence of the electric current, but not when alumina is dissolved in aluminium fluoride alone." Rose determined that cryolite, which is easy to pulverize and not hygroscopic or volatile, gave better results than aluminium chlorides or their combinations with chlorides of the alkali metals. Bunsen and Deville experimented in 1856 on the electrolysis of molten cryolite, but could not obtain the required electric current.

Chemical plants were built at Paris and Salindre. Th. Bell established a plant using Deville's process at Washington-on-Tyne in England. He also experimented with the electrolytic process. These plants were worked for about thirty years without material changes, but later magnesium was used as the reducing agent instead of sodium.

M. Heroult in 1887 constructed a practical electric reduction furnace for the commercial manufacture of aluminium by electrolysis, using alumina dissolved in molten cryolite. The fundamental principles of the furnace were chiefly those suggested thirty years previously by Bunsen and the electrolysis of the alumina

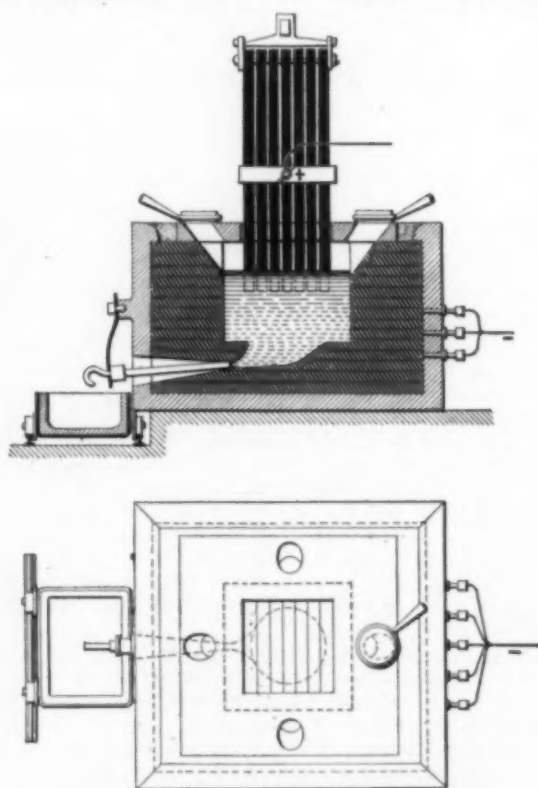


FIG. 1. HEROULT'S FURNACE

dissolved in cryolite was well known to Deville and others. The only novel feature, as was pointed out, was that the current was used both for the reduction of the aluminium and for heating the furnace, while before it had been the practice to heat the furnace externally by means of combustion. Bradley obtained a patent in America on just this idea.

Heroult's furnace, Fig. 1, consisted of an iron casing lined with carbon bricks. The current was introduced through a bundle of carbon anodes which could be raised or lowered by means of a chain. The total cross-section of the anode was  $30 \times 30$  sq.cm. and the length 1.2 m. The bath occupied a space of  $50 \times 30$  sq.cm., the inside height being 60 cm. The electric current varied from 3000 to 4000 amperes and was supplied by a generator at from 13 to 14 volts. The current passed through the molten cryolite, in which the alumina was dissolved, down to the casing which comprised the cathode. The alumina was decomposed and the aluminium settling at

\*Translated from *Teknik Tidskrift*, August, 1917.



the bottom was drawn off, while the oxygen liberated, in contact with the anode, combined with the carbon to form carbon monoxide, which is immediately burned, forming carbon dioxide on contact with the air. The carbon anodes are in this manner gradually used up. The raw materials were supplied to the furnace through openings in the fireproof cover. Heroult produced aluminium in large quantities and it is unquestionably to him that the credit belongs for having developed the electrolytic method so that it became of practical importance in France.

In Calypso, Minet experimented with lowering the temperature of the bath. He used aluminium fluoride with 60 per cent sodium chloride and also cryolite with 50 to 80 per cent salt. Minet's furnace, Fig. 2, has both the anode and cathode suspended in the bath; this is, however, not good practice. It reminds one of Bunsen's experimental furnace, Fig. 3. Hall experimented in America on adding to the cryolite, which was mixed with alumina, potassium, sodium, lithium, chloride and also calcium fluoride.

Following the Bucherer patented process, it is said that the Aluminium Industries Co. in Neuhausen carried out successful experiments on electrolyzing aluminium sulphide,  $Al_2S_3$ . The furnace voltage was very low—5 volts—and the metal pure. The sulphur was

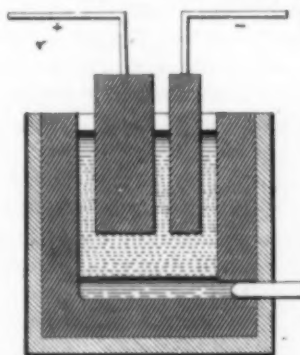


FIG. 2. MINET'S FURNACE

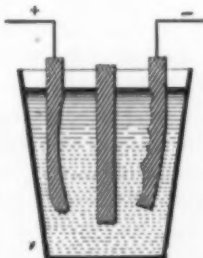


FIG. 3. BUNSEN'S FURNACE

condensed and used again for producing new aluminium sulphide. The production of the aluminium sulphide by heating alumina, carbon and sulphur requires so much heating that the process was too expensive. The process now generally used in Europe for manufacturing aluminium has been developed directly from Heroult's furnace, although the type now in use has been much enlarged and improved. Heroult died shortly before the war with Germany broke out.

The great future that was entertained in the minds of many for aluminium and its production is reflected in the fact that during the '90s a large number of patents were taken out, the majority being more or less valueless. According to some of these patents, aluminium should be produced by electrolysis of water solutions. This could, of course, not lead to any commercial results, as aluminium in *status nascendi* is hydrolyzed by water. Also, according to others of these patents, aluminium should be produced directly by reduction with carbon in electric arc furnaces or in electric resistance furnaces. However, at the reduction temperature of 2000 deg. C. mostly aluminium carbide was produced. If this problem could be solved and aluminium manufactured in large furnaces of several thousand

kilowatts instead of in the present electrolytic baths of about 150 kilowatts, it would, of course, be of immense value.

Cowles tried in America and at Milton in England to smelt aluminium and carbon in retorts, but the product which he obtained was valueless, as it contained too much carbide. His furnace, Fig. 4, was  $1\frac{1}{2} \times 1\frac{1}{2}$  m. and

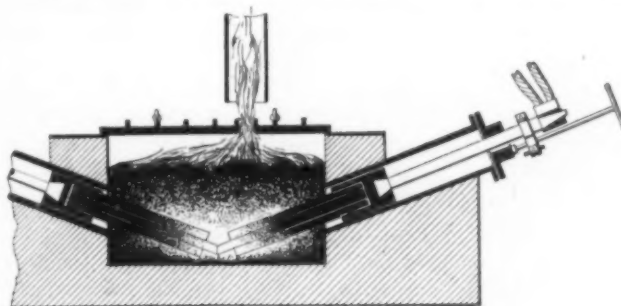


FIG. 4. COWLES' FURNACE

$\frac{1}{2}$  m. high. Cowles did, however, produce aluminium alloys, and avoided thereby the formation of carbide.

Moissan, in an experimental furnace, Fig. 5, obtained aluminium with some carbide content and, besides, carbide and corundum crystals. He heated alumina and carbon in a carbon tube by means of an electric arc. Many chemists have worked with this reaction, but without practical result. To prevent carbide and oxidation formations Ruff and Giuliani suggested vacuum furnaces in which the reaction would take place around 1500 deg. C. Askenasy suggested just the opposite, i. e., pressure furnaces.

#### THE COMMERCIAL PRODUCTION OF ALUMINIUM

Only a few kg. of aluminium were produced during the first years succeeding 1854, and from 1863 to 1878 the yearly production did not exceed 2 kg.; from 1878 to 1888 between 10 and 40 tons were produced. The price was more than 1000 fr. per kg. at the beginning, but due to installation of Deville's and other processes it dropped to 300 and later to 100 fr. It was, however, not until the latter part of the '80s that the price fell to an economical level because the electrolytic plants in-

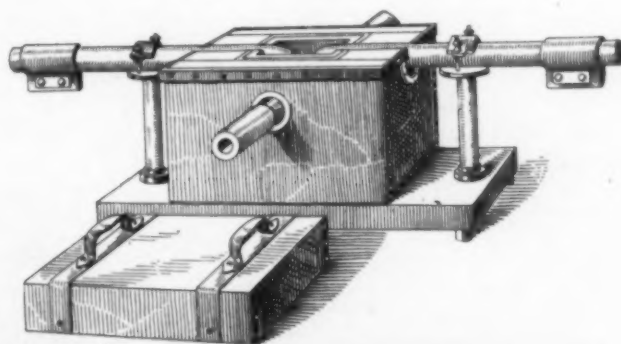


FIG. 5. MOISSAN'S FURNACE

creased the production so that in 1891 it amounted to 333 tons at a price of 4 fr. per kg.

From the diagram, Fig. 6, it is seen how rapidly the production increased. After 1893 the price dropped still more and was in 1900 or 1901 about 1.60 fr. per kg. On account of this drop the International Aluminum Syndicate was formed, the object of which was to en-

deavor to control the market and get better prices. La Société-Electrometallurgique Français des Froges, La Compagnie des Produits Chimiques d'Alais et de la Carmargue, Alluminum Industrie Gesellschaft Neuhausen, Pittsburgh Reduction Co. or the Aluminum Company of America and finally the British Aluminum Co. were the members of this syndicate. The production as well as the consumption of aluminium increased, and the price went up and reached 3.20 fr. per kg. in 1907.

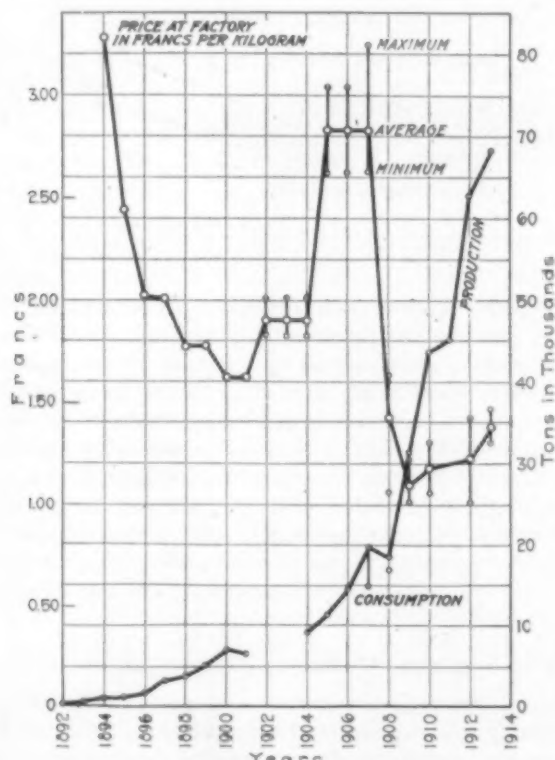


FIG. 6. PRODUCTION AND PRICES

The over-production of the years following and the general business depression caused a violent drop in the price. English firms fought against bankruptcy, many plants were shut down, the syndicate was dissolved and the price dropped to 1 fr. per kg. The price, however, increased before the war to more than 2 fr. and all plants began operation again. A few even enlarged their facilities. A French syndicate was again formed in 1910, and it became international in 1913.

The yearly production before the war was 68,000 tons, divided as follows:

	Per Cent
United States .....	33
Canada .....	8
Switzerland, Germany and Austria .....	17
France .....	26
England .....	11
Norway .....	2
Italy .....	1

France and Switzerland were the countries that exported most aluminium, the amount for the last years before the war being 7000 to 8000 tons each. Germany, on the other hand, has imported aluminium; the statistics being 16,000 tons in 1912 and 12,500 tons in 1913.

It is difficult to obtain accurate information in regard to the aluminium production during the war. The prices have been abnormally high and a large number of new plants have been built, and contracts entered into for deliveries for several years after the war. Ger-

many and Russia will probably be the chief future consumers in the international market. It is possible that if all the plants which are building or contemplated are put in operation, the production after the war may be doubled, in which case we may figure on a yearly production of around 150,000 tons, divided as follows:

	Before the War Per Cent of 68,000	After the War Per Cent of 150,000
United States and Canada .....	41	50
Switzerland, Germany and Austria .....	17	13
France .....	26	13
England .....	11	8
Norway .....	2	11
Italy .....	1	4

For Norwegian factories it may be proportioned as follows:

	Tons
Arendal .....	5000
Tyssedal .....	6000
Vigeland .....	2000
Stangfjord .....	600
Hoyang .....	4000

These estimates have recently been made by a French engineer and indicate that France does not expect to keep up the hold it had on the aluminium industry before the war. When, however, the French saw the threatened competition of other countries, they immediately proceeded to build factories of their own in these countries. From a financial standpoint France will, therefore, continue to be the leader in the aluminium industry for some time to come. The French have been able to maintain this position, not only on account of their large bauxite deposits, but mainly due to the fact that they have been the pioneers of both the chemical and later the electrochemical aluminium industry. Not only have they tried to improve the methods of its production, but at the same time they have devoted just as much attention to finding new fields for its utilization. It may be predicted that, next to iron, aluminium will be the most important industrial metal.

These results could never have been obtained if it had not been realized from the beginning that an impure aluminium would have greatly discredited the product, and the problem has therefore all along been one of producing as pure a metal as possible.

#### METHODS OF REFINING RAW MATERIALS— ALUMINA FROM BAUXITE

At present there exists no satisfactory process for purifying metallic aluminium, and the only manner in which a pure product can be obtained is by the use of pure raw materials. This was clearly understood by Deville. The main raw materials for production of aluminium are alumina and carbon electrodes, and the obtaining of these with the required purity will be described in the following:

The alumina is produced by purifying bauxite, the red grade of which contains large amounts of impurities such as iron oxide and silica. According to the Deville-Pechiney process the bauxite is pulverized and mixed with anhydrous sodium carbonate in the ratio of 75 per cent bauxite and 25 per cent soda. The mixture is then heated two to three hours in a reverberatory furnace, whereby sodium aluminate is formed. This is separated from the iron oxide by leaching with warm water. The alumina is then precipitated from the extract solution by passing carbonic acid through the strong liquor, the carbonic acid being obtained from the



reverberatory furnace or lime calcining ovens. The process takes 5 to 6 hours at 70 deg. C. The precipitated alumina is then washed with clean water, filtered and dried and is then ready for the production of aluminium. The carbonated solution is evaporated and the soda recovered.

The Deville-Pechiney process is not economic as far as the fuel consumption is concerned and the Bayer method has superseded it. The operation of this is also somewhat simpler. The red bauxite is pulverized so as to pass through a screen of 5 mm. mesh and is cal-

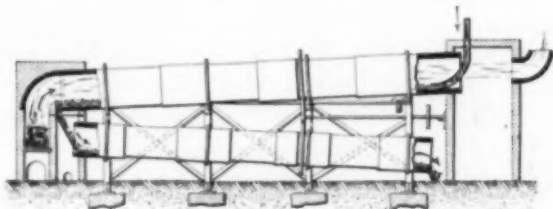


FIG. 7. CALCINING FURNACE

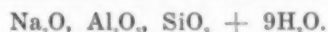
cined in an oven such as is shown in Fig. 7, where the vegetation matter is burned off. The temperature is kept at 700 deg. C. and may not exceed 900 deg. C. as the higher burned alumina is less easily dissolved in the caustic solution. The calcining oven is about 10 m. long and has a diameter of about 1 m. The slope is 1 : 25 and the rotation is very slow. The lining consists of fireproof brick. The material is fed at the upper end of the upper tube and passes through the same in the opposite direction to the flame. The cooling takes place in the lower tube, which is smaller than the upper one. The bauxite is thereafter pulverized and sifted. The Verge process eliminates the preliminary treatment.

In the Bayer process the bauxite is now put into an autoclave and subjected to the action of a caustic soda solution of 1.45 sp.gr. It is heated with steam at 5 to 6 atmospheres pressure and agitated for two to three hours, the temperature being from 150 deg. to 160 deg. C. A solution of sodium aluminate is thus formed and is diluted to a sp.gr. of 1.23, from which the insoluble iron oxide is separated. The filtered sodium aluminate solution is then not treated, as in the Deville-Pechiney process, with carbon acid, but the diluted (1.23 sp.gr.) solution is agitated for 36 hours with a small quantity of freshly precipitated hydrate of alumina. This is done in autoclaves, such as shown in Fig. 8, having a diameter of about 4 m. and a height of about 6 m. About 70 per cent of the dissolved alumina is thus precipitated from the caustic and separated by filtration.

The hydrated alumina is then filter-pressed under a pressure of 5 atmospheres, and the product is thereafter air-dried and calcined in tubular kilns, lined with magnesite brick. These kilns are about 6 m. long, have a diameter of 1.8 m. and are fired with gas. Even though the water is driven out at a low temperature, the alumina is heated to red heat at a temperature of about 1100 deg. C., as the alumina thereby becomes only slightly hygroscopic and can be used directly for production of aluminium. The diluted soda solution is again brought up to a sp.gr. of 1.45 in vacuum stills and can then be used again.

With both Deville's and Bayer's method it is necessary to use a bauxite with a low silica content, as too

much of the latter will cause a loss in alumina in that in the soda solution there is formed a non-soluble aluminium-sodium silicate of the approximate formula



In French bauxite of 61 per cent  $\text{Al}_2\text{O}_3$  and 3 per cent  $\text{SiO}_2$ , 5 per cent of the alumina is lost and the silica content in the final product will not exceed  $\frac{1}{3}$  per cent. Verge reaches the same favorable result with a bauxite having twice the content of silica, and uses only a temperature of 125 to 135 deg. C. in the autoclaves. Peniakoff produces alumina, similarly to Deville-Pechiney, in a furnace. He uses a 30 m. rotating kiln, slightly inclined, and reduces a mixture of bauxite and sodium sulphate with coal at a temperature of 1200 deg. C. The acid fumes after having been exposed to the air and steam are passed over salt, producing sodium sulphate. The hydrochloric acid which is formed thereby is recovered as a by-product. The process is thereafter identical to Bayer's.

White bauxite, which contains up to 25 per cent silica and up to about 5 per cent iron oxide, is purified in an entirely different manner from the red bauxite. It is pulverized and slightly heated so as to make it more porous. Warm sulphuric acid of 1.45 sp.gr. is thereafter cautiously added to the bauxite, and aluminium sulphate is formed under violent boiling. Steam and water are then added to reduce the sp.gr. to 1.2. The iron is dissolved as ferrous or ferric sulphate together with aluminium, and if the bauxite contains

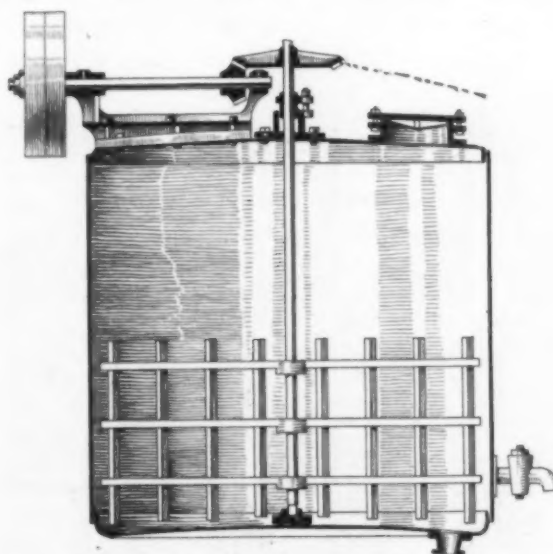


FIG. 8. AUTOCLAVE USED IN CAUSTIC PROCESS

magnesium, this is also dissolved. After it has been determined that no free sulphuric acid remains, the silica is separated.

The iron can be separated in different ways, either before solution, by oxalic acid, or after the decantation, with ferrocyanide of potassium or calcium sulphide. The aluminium sulphate solution is evaporated and the sulphate calcined in reverberatory furnaces.  $\text{SO}_2$  or  $\text{SO}_3$  is liberated during the heating and is again changed to sulphuric acid. The alumina which remains is non-hygroscopic and can be used directly for making aluminium. For satisfactory aluminium production the refined ore should contain at least 98 per cent  $\text{Al}_2\text{O}_3$ , not

more than 0.3 per cent  $\text{SiO}_2$ , or 0.1 per cent  $\text{Fe}_2\text{O}_3$ , and not more than 1 per cent  $\text{H}_2\text{O}$ .

Hall, in America, in connection with the Pittsburgh Reduction Co., has used a more direct method for purifying the bauxite. He uses an electric arc furnace constructed somewhat on the same principles as a carbide furnace. The bauxite is first calcined and mixed with 10 to 15 per cent carbon depending on its impurities. At the temperature of the electric furnace the silica, iron oxide and eventually the titanium oxide are reduced and also part of the alumina. There is formed a fluid alloy of iron, silicon, titanium and aluminium which sinks to the bottom and is drawn off. This alloy constitutes a valuable by-product. This simple method is reported to be feasible for the use with clay or aluminium silicates. The purified alumina will, however, not be as pure as by the chemical processes, and will not dissolve as readily in the cryolite bath.

Cowles and Kayser have also used the electric furnace for producing pure alumina. Kaolin, feldspar or clay was mixed with sodium chloride or calcium chloride in the ratio of 18 parts pure alumina to 23.4 parts salt, and in order to get the reaction to proceed more rapidly 15 per cent charcoal, produced from sawdust, was added. Briquets of this mixture to which some water was added were exposed to a temperature in the furnace corresponding to the temperature of volatilization of the salt. The oxidizing action of the steam prevents the sodium from escaping and there is formed a sodium-silica-alumina composition, and hydrochloric acid is evolved.  $2\text{SiO}_2, \text{Al}_2\text{O}_3$ , plus  $4\text{NaCl}$  plus water and carbon =  $2\text{SiO}_2, \text{Al}_2\text{O}_3, 2\text{Na}_2\text{O}$  plus  $4\text{HCl}$  plus water and carbon oxide.

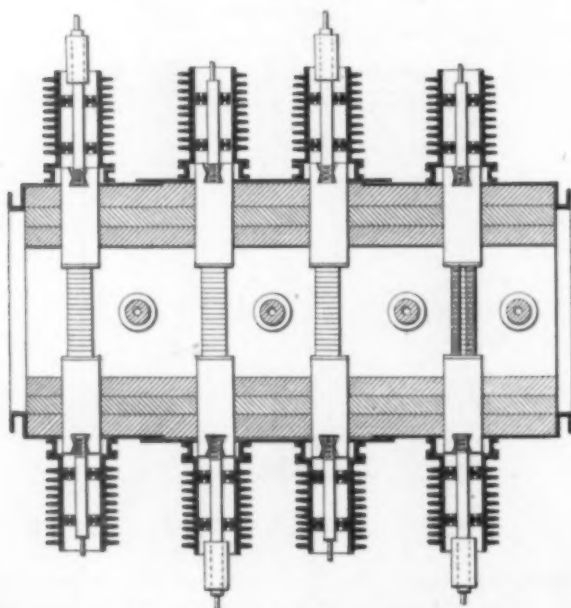
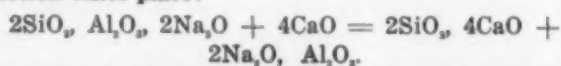


FIG. 9. SERPEK NITRIDE FURNACE

The hydrochloric acid is condensed to 18 deg. Baume and the salt as well as part of the aluminium chloride is recovered in chambers. After this, the mass is treated with lime in a revolving furnace and the following reaction takes place:



An excess of lime will form an insoluble calcium aluminate, while a shortage will cause part of the

insoluble sodium-silica-alumina composition to be unchanged. The alumina is separated from the soda solution and treated in the usual manner. The silica-lime composition can be used as a by-product for glass and cement manufacture. The hydrochloric acid can be used for producing a double chloride of aluminium and potassium by utilizing the feldspar.

Dr. Serpek, before the war, made very good progress with the  $\text{AlN}$  reaction in the production of both alumina and ammonia. He demonstrated the great affinity of aluminium for nitrogen at high temperatures. In conjunction with Badin, Dr. Serpek worked intensively

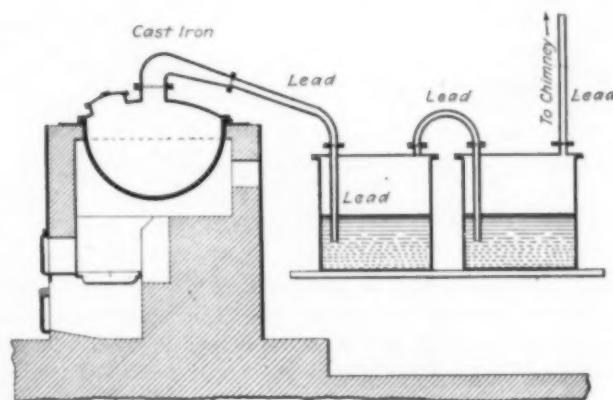
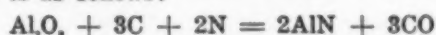


FIG. 10. HYDROFLUORIC ACID STILL

with large revolving furnaces or kilns, in which alumina was acted on by carbon and nitrogen at temperatures from 1600 to 1800 deg. C. By using a catalyst, such as iron and steam, it was possible to start the reaction even at 1300 deg. C. The furnace is lined with aluminium nitride, and the cross-section of an actual furnace is shown in Fig. 9. The electric resistance consists of carbon disks. There are eight columns, each 1.2 m. long, which are connected in series, and which take 10,000 amperes at 230 volts direct current. This gives a temperature of 1800 deg. C. in the furnace. The reaction is as follows:



When this aluminium nitride is treated in an autoclave with steam under pressure, it gives alumina and ammonia,



After the ammonia has been liberated the alumina can be used over again in the furnace. If, on the other hand, it is desired to use the alumina for producing aluminium, then the aluminium nitride is mixed with soda lye and the ammonia is liberated at 2 atmospheres pressure after from 2 to 2½ hours. The ammonia may be used for producing nitric acid, ammonium nitrate or ammonium sulphate.

The alumina is treated further according to the Bayer method. The treatment in the autoclaves is, however, simpler, as, according to Serpek, only 2 atmospheres pressure is required instead of 8 atm. The process is shorter and the concentration only 20 deg. B. instead of 40 deg. B. It is, therefore, claimed that the Bayer-nitride process costs only 63 fr. per ton of aluminium as compared to 126 fr. for the old Bayer process. This does not, however, include the cost of the bauxite. Besides this, ½ ton of nitrogen is fixed per kw.-year, cor-



responding to 2 tons of alumina. It will be of great interest to follow the results obtained by the aluminium-nitride process, and in this connection it may be of interest to learn that the Société Générale des Nitrures is also experimenting with ferro-aluminium, which has shown tendencies to combine with nitrogen, the reaction being exothermic. It is unfortunate that Badin has recently died. It is doubtful whether Dr. Serpek is continuing his experiments in Paris or St. Jean de Maurienne.

The subject of producing a pure alumina has been dealt with rather in detail, but it is absolutely essential that this part of the problem is thoroughly understood before one can have any hope of a satisfactory aluminium production. A number of prominent chemists are constantly working on this important problem.

#### CRYOLITE AND BATH FLUXES

Before proceeding to the electrode question, a few words may be said about the cryolite in which the alumina is dissolved. The natural cryolite, such as it is found at Tvigtut, Greenland, or at Miask, in the Urals, has the chemical formula  $\text{Al}_2\text{F}_6 \cdot 6\text{NaF}$ . The chief impurities are quartz, iron and lead, and it is mechanically purified by hand picking and with electro magnets. As obtained from the chemical factories at

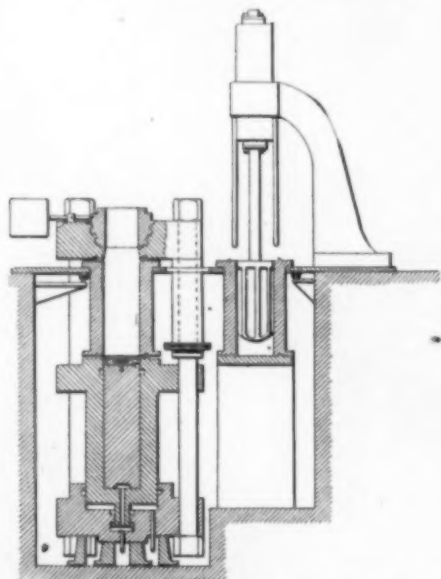


FIG. 11. VERTICAL ELECTRODE PRESS

Oresund or La Compagnie des Produits Chimiques d'Alais et de la Camargue, it contains about 50 per cent fluorine and 12 to 13 per cent alumina, but only  $\frac{1}{2}$  to  $\frac{1}{3}$  per cent silica and  $\frac{1}{10}$  per cent iron.

Cryolite melts at about 1000 deg. C., and when heated to red heat it liberates up to 1 per cent of water. At white heat sodium fluoride and fluorine will gradually escape and the alumina will be left. The artificial cryolite contains more fluorine, its chemical formula being  $\text{Al}_2\text{F}_6 \cdot 4\text{NaF}$ . It is, therefore a better raw material, but it smokes more. It is produced by treating hydrated alumina and ordinary salt with hydrofluoric acid or by other methods. The hydrofluoric acid must first be produced and is made by distilling a mixture of pulverized fluorspar with concentrated sulphuric acid, the HF being absorbed in water. Such a still is

shown in Fig. 10. The hydrofluoric acid causes bad burns and attacks the mucus membrane. One must therefore be extremely careful when working with it, and precautions such as wiping the hands with vaseline or the use of gas masks are to be recommended.

The fluorspar should not contain silica or silicates, as the formation of silicon-tetra-fluoride would result, which changes over to colloidal silicic acid, which renders the aluminium impure. The silica can, however, be removed by fluoride of potassium.

As the bath in the aluminium furnaces constantly loses fluorine, this must be replenished. If, however, fluorine was added in the form of cryolite, the bath would gradually be richer in sodium, which would go into the aluminium. Aluminium with only 100 per cent of sodium is brilliant, while a content of  $\frac{1}{10}$  per cent makes it dull and the utensils made therefrom will take on a dark color.

Aluminium fluoride,  $\text{Al}_2\text{F}_6$ , is therefore added from time to time to the bath, this being produced from hydrated alumina and hydrofluoric acid or aluminium sulphate and cryolite. Natural calcium fluoride, i.e., fluorspar, is also used.

#### MANUFACTURE OF CARBON ELECTRODES

The electrode production in an aluminium factory is of utmost importance inasmuch as the electrode consumption equals the weight of the aluminium produced. The electrodes must furthermore be of a special grade in that the ash content should not exceed 1 per cent. For an economical aluminium production, it is advisable to erect an electrode plant near the aluminium works, as in this manner it will be possible to use the waste from the old electrodes, which may amount from 10 to 30 per cent of the total consumption.

Ordinary coal or coke cannot be directly used for the manufacture of electrodes, as even the purest anthracite will give electrodes having an ash content of more than 2 per cent, of which at least 13 per cent is silica. Natural graphite or baked carbon is not sufficiently pure, and graphite is in general too expensive for aluminium production in that its high electric conductivity cannot be utilized. The current density should be from about 0.6 to 1.0 ampere per sq.cm. and even a lower density is often used. The consumption is not reduced by using graphite, because it is the oxidation during the electrolysis which consumes the electrodes. Retort graphite may be used, but this contains as a rule too much silica, so that it is used in addition to other materials. Acheson graphite is very pure, but is now too expensive in Europe. In general petroleum coke is the best material, although it is high priced. It has a low ash content of from 0.1 to 0.4 per cent and seldom goes over 0.5 per cent. The American petroleum coke is generally purer than the Rumanian. It is produced by distilling heavy crude oil which is heated to a dark red heat, the product being a porous, partly hard and partly soft shining mass with a grain-like structure.

Petroleum coke contains 10 to 15 per cent of readily volatile matter, or even as high as 20 per cent. This volatile matter must first be driven out by calcining at red heat, otherwise it is impossible to obtain good solid electrodes. The larger pieces of the coke are first crushed in ordinary crushers to the size of a walnut. The ovens, such as designed by Frans Meisser, are about

5 x 6 m. and about 6 m. high with 8 retorts having an inside diameter of about  $\frac{1}{2}$  m. These retorts are filled from the top and emptied successively every three to four hours through water-cooled passages in the bottom. The retorts are heated by gas, which first passes through an economizer, which comprises one-half side of the oven. The preliminary heating takes nine to twelve hours.

After the calcining, the petroleum coke, together with the old waste electrodes, is pulverized and some retort graphite is added. If the pieces are large it may first be necessary to pass them through crushers, and thereafter pulverize them in ball mills. The petroleum coke is now mixed with up to 20 per cent of a pitch binder. Some plants use tar thickened with about one-third pitch. A little soot will make the electrodes more homogenous, but it is as a rule likely to be too impure. In order to protect the electrodes from burning it is also recommended that a little alumina be added. If the tar contains water, it should first be heated to evaporate it. Coal tar pitch obtained from coke ovens may be used, as it contains not over 1 to 2 per cent of ash, but one must be careful and not use blast furnace tar, which often contains as high as 20 per cent of ash.

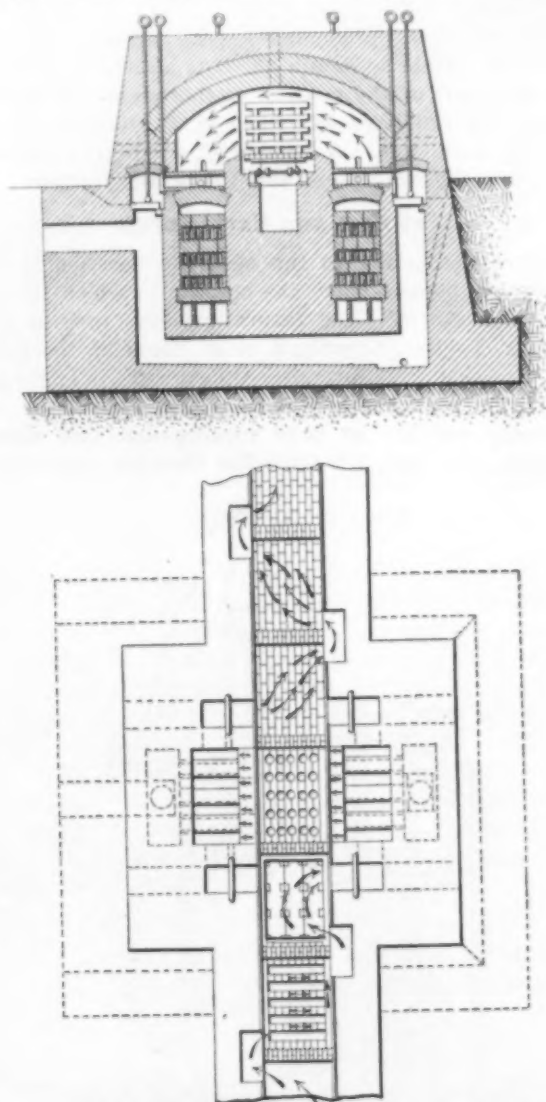
The substances are mixed in steam heated kneading machines. Such a machine has two Z-shaped kneaders, which rub on each other and the steam jacketed chamber walls. When the mixture is sufficiently kneaded the container is opened and the mass brought by a conveyor to the molds or presses. In these they obtain their final form and compactness, the pressure being up to 500 atmospheres. The higher the pressure, the more compact will the electrodes be and the less binder will be required, which is an advantage, as the space occupied by the binder will always be more or less void when the electrodes are baked and the tar oils volatilized.

The construction of the presses depends naturally on the size of the electrodes. In an aluminium furnace it is advisable to use several electrodes so as to make it possible to make renewals without breaking the current or lower the potential. Several furnaces or ovens, up to 40, may be connected in series and the electrodes are constantly being changed and adjusted. If the current had to be broken at each change of electrode, a continuous operation would be impossible. The size of the electrodes depends both on the number and on the electric current which the furnaces require. From 8000 to 10,000 amperes is common, while much larger sizes are in use, requiring a current of from 15,000 to 20,000 amperes. The cross-section of the electrodes varies from 20 x 20 sq.cm. to over 40 x 40 sq.cm., and the length may be more than 1 m., although it is common practice to use a nearly cubical form for the larger sizes.

The electrode press, shown in Fig. 11, is of the vertical type and equipped with a preliminary press and a turntable. The cylinder is first packed full with the mixture by the outer piston and then moved to the middle position, where the center piston presses it through the mouthpiece. If short electrodes are desired, they are simply cut off to the required length. Such a press is about 4 $\frac{1}{2}$  m. high and takes up a floor space of 4 to 5 $\frac{1}{2}$  m. It can press the largest electrodes needed for the aluminium industry.

Another method is that of pressing the short electrodes directly in a mold, in which case the mass does not pass through any mouthpiece. There are many designs of vertical and horizontal electrode presses with or without preliminary presses, but as a rule the simplest and the strongest are the best.

After the electrodes have been pressed and formed they are baked in furnaces. This makes them solid, compact and highly electro-conductive due to the re-



FIGS. 12 AND 13. CROSS-SECTIONS OF MENDHEIM-JEHL ELECTRODE FURNACE

moval of the insulating tar oils. The heating must be done slowly, otherwise they may be less compact and may easily crack. Thus, for example, several days are required for firing the larger electrodes. The temperature is gradually raised to more than 1400 deg. C. and during the operation the electrodes lose about 10 per cent of their weight.

Modern European furnaces are gas fired and the electrodes are protected by being placed in crucibles of a refractory material. The empty space around them is filled with retort graphite, which is a good heat conductor, or with pulverized petroleum coke or electrode waste.

Much experimenting has been done to do away with the gas producer and to get the gas from the fresh pe-



troleum coke in the retorts. No satisfactory method was, however, found until a few years ago, as the mass shrunk so much that the electrodes became directly exposed to the flames.

Of the many different furnace designs may be mentioned Mendheim's muffle furnace of the Bock type, where the electrodes are passed through a passageway toward the center of the furnace, where the heat is greatest. The electrodes are placed on trucks, which thus are pushed through the furnace by hydraulic pistons. They are preheated by the waste gases and cooled by the air required for the furnace draft, which in this manner also becomes preheated. The electrodes are

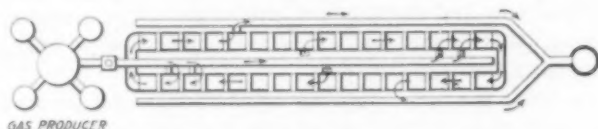


FIG. 14. MEISSER FURNACE

baked in this furnace at a temperature of 1350 deg. C., which is sufficient for electrodes to be used in aluminium reduction where the temperature of the bath is around 1000 deg. C.

A modification of the above furnace has been devised by Jehl, and consists of a system of partitions or chambers. Figs. 12 and 13 show the center portion of such a furnace where the baking takes place. The tunnel on both sides of the furnace has a similar section; and the waste gases pass the economizer on one side and thus preheat the electrodes which are brought into the furnace. The air cools the finished electrodes and is further heated by the economizer.

The more generally used ring-furnace is that of Frans Meisser. As seen from the diagrammatic sketch in Fig. 14, it consists of sixteen chambers on each side

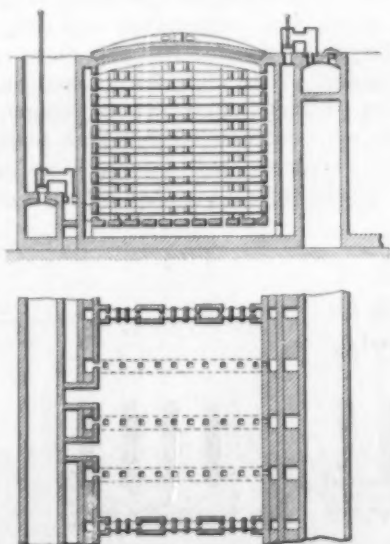


FIG. 15. SECTION OF MEISSER FURNACE

of a gas flue. These chambers may be 2 m. long, 1.5 m. high and 1.5 m. wide, or even larger. Two of the chambers are always idle for taking out finished electrodes and for putting in new ones and can be separated from the others by removable partitions. Fresh air enters the furnace from neighboring chambers and is heated in the next five or six chambers, while these as

well as the electrodes therein are cooled. In the next or next two chambers the producer gas is burned and gives off its heat to the following six chambers, after which the waste gas passes off through the chimney.

In the other side of the furnace the process is similar, and as the electrodes are baked and replaced by fresh ones the chambers are cut in and the neighboring one opened and emptied, and so on, according to a predetermined cycle of operation.

Fig. 15 shows the construction of the furnace, the gas flue being in the center between the two rows of chambers. By means of a double elbow pipe the gas is led down and out through the small openings, where it meets the air and burns. The air has entered in the previous chamber, where the pipe has been removed. When a chamber is to be emptied, inspected or recharged, the cover is removed by a traveling crane; the partitions which separate the chamber from the rest must, however, first be put in place.

Mendheim has recently designed a ring-furnace, where retorts are unnecessary in that the chambers

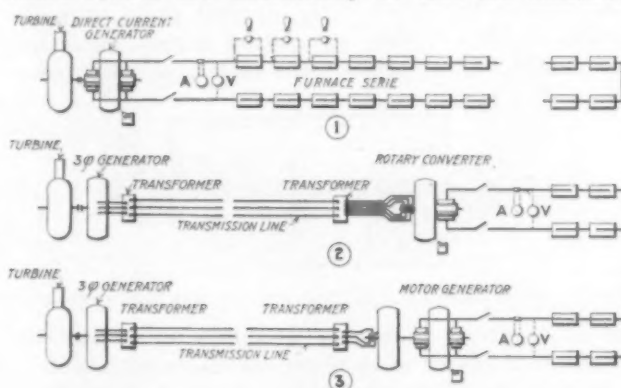


FIG. 16. TYPES OF ELECTRIC INSTALLATION

themselves serve this purpose. They are surrounded by hollow walls through which the gases pass. Fresh coke is used as the packing filler and is tamped tight around the electrodes to such a thickness over them that they will not become exposed when the coke shrinks down. The most remarkable feature of his furnace is that after the material has become ignited for a time by the aid of a small gas-producer the latter can be shut down and the distillation gases from the volatile matter in the binder of the electrodes and the coke filler can be utilized for heating the furnace itself. It is claimed that the gas supply is more than sufficient to bring the furnace temperature up to the highest values.

#### THE ELECTRIC INSTALLATION

The raw materials for aluminium production, i.e., alumina, cryolite and the electrodes, have been dealt with in the above, but in addition to these a large supply of direct current is required for electrolysis and heating the furnace. Each aluminium furnace takes from  $6\frac{1}{2}$  to  $7\frac{1}{2}$  volts, and in starting it requires wider limits, from  $5\frac{1}{2}$  to  $8\frac{1}{2}$  volts. It is, of course, not economical to build generators of such a low voltage and from 30 to 40 furnaces are, therefore, connected in series. The operating voltage for 35 furnaces in series will, therefore, be about 250 volts.

As is apparent from diagram 1 in Fig. 16, it is preferable if the aluminium works can be located near the

power house. The direct current generator can then be directly driven by the turbine and the current delivered economically to the furnaces. The regulation from zero volts up to maximum is accomplished simply

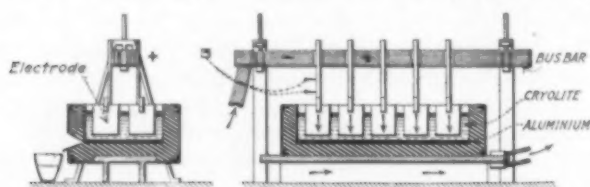


FIG. 17. VERTICAL SECTIONS OF ALUMINIUM FURNACE by a field rheostat. If several generators are required, they may be operated in parallel. If there are several series of furnaces, these can then be operated independently of one another. This simple arrangement should be used if the waterpower is located near a port, while if it is located in the interior, it depends on the local transportation facilities whether the factory should be built near the power house or not. If not, the energy may be transmitted over a transmission line according to diagram 2 or 3. In both these cases the turbine drives a 3-phase alternating current generator, and if the distance between the factory and the power

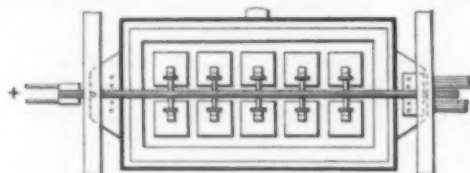


FIG. 18. HORIZONTAL SECTION OF ALUMINIUM FURNACE station is great, it may be necessary to step-up the voltage to a higher value by means of transformers.

In diagram 2 the conversion of the 3-phase alternating current to direct current is accomplished by a synchronous converter, and in diagram 3 by a motor-generator. The former gives a little higher efficiency, but the direct current voltage cannot be regulated from zero and up, and if adjustments are required, the trans-

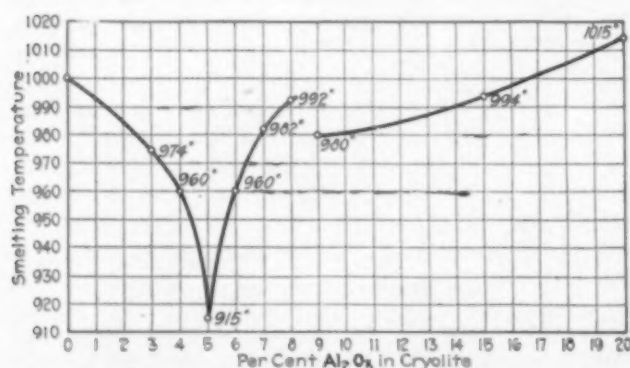


FIG. 19. MELTING POINTS OF ALUMINA-CRYOLITE

former taps must be changed or a booster must be provided. This is connected in series with the alternating current supply circuit, and by increasing or decreasing its field excitation, the voltage which is applied to the converter terminals is raised or lowered, thus also raising or lowering the direct current voltage. Synchronous converters are mostly used in America and England, and motor-generators on the Continent.

As shown in Fig. 16, voltmeters and incandescent

lamps are used for reading the voltage of each furnace, and the current, which is, of course, the same for all the furnaces in the series, is measured by an ammeter and the main potential by a voltmeter. The instruments on the alternating current side are not shown.

#### THE MANUFACTURE OF ALUMINIUM

The aluminium furnace in Figs. 17 and 18 has the electrodes supported by means of copper bars from a set of crossbars. The vertical bars are fastened to the crossbar by means of clamps and bolts or keys and to the electrodes by means of a bolt which is screwed or molded into the electrode. The furnace casing is lined with carbon and the current enters from the crossbar, through the furnace and down to the iron bottom which comprises the negative pole.

To start the operation the electrodes are all lowered, the current is thrown on, and as the furnace heats up it is filled with cryolite, which melts. If the bath gets

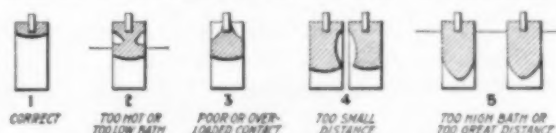


FIG. 20. ELECTRODE CONSUMPTION

too high, the electrodes can be raised by adjusting bolts. The furnace is tapped or scooped out every third or fourth day, the ingots varying in size from 2 to 40 kg.

The cryolite melts around 1000 deg. C., but if a little alumina is dissolved therein the melting temperature drops as shown in Fig. 19, the melting point being at a minimum with 5 per cent alumina dissolved. With from 8 to 9 per cent alumina a break in the curve seems to occur, and the cause of this is probably that the composition of the cryolite has been changed. If aluminium fluoride is added, the temperature will drop still further, and aluminium fluoride will also more readily dissolve the alumina. With 20 to 30 per cent alumina, the bath becomes thicker and there is danger that the alumina may only not dissolve but sink to the bottom, whereby the resistance will increase and cause local heating, or the aluminium together with the carbon may

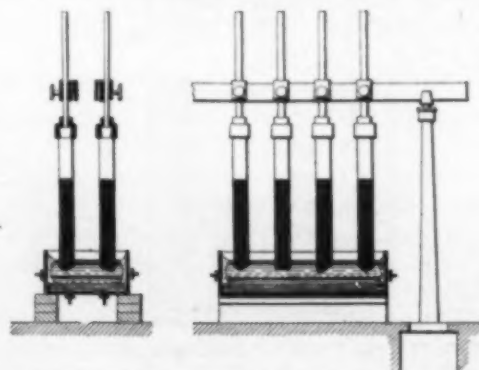


FIG. 21. ALUMINIUM FURNACE USING CRYOLITE CRUST FOR CONTAINER

form a carbide,  $\text{Al}_4\text{C}_3$ . This aluminium carbide, which generally is formed when the operation is carried on at too high a temperature, is yellow and of hexagonal crystallization. When mixed with water at ordinary temperature, it forms slowly alumina and methane gas.



Moisan has therefore drawn the conclusion that the methane vapors which issue from the ground may be caused by aluminium carbide in the interior of the earth.

The temperature is also of importance as far as the electrode consumption is concerned, and as shown in diagram 2, Fig. 20, at an excessively high temperature the air will quickly oxidize the electrode. Not enough

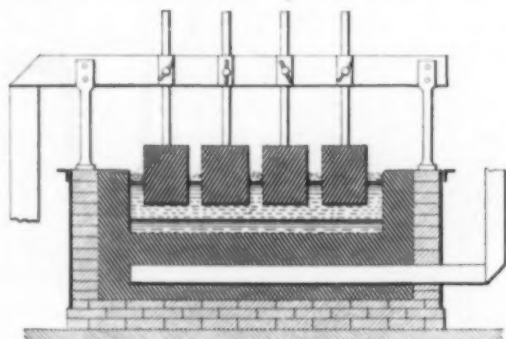


FIG. 22. UNIT NEGATIVE ELECTRODE AND CONTAINER

distance between the electrodes creates a condition as shown in diagram 4. If the bath is too high, the electrodes will be pointed, as in diagram 5, and if the contacts are poor, they will take a shape as in diagram 3. Diagram 1 shows the desired form.

The temperature also affects the composition of the bath in that at high temperatures the fluorine evaporates and must be replaced by aluminium fluoride. At a low temperature, a hard crust is formed over the bath. As the aluminium melts at from 625 to 700 deg. C. it may be difficult to draw off the metal at a low temperature, or it may rise in the bath and cause a short circuit of the furnace. When aluminium approaches the solid state, it becomes lighter than the bath, while in a molten form it is slightly heavier. For these reasons it is often necessary to cut out a furnace of the series, and it happens also that a hole is burned therein or that the electrodes get stuck or "freeze," so that they cannot be regulated. One electrode may then get too much current or the copper connections may melt, and if things go wrong all the copper bars, one after the other, may melt. If it has been decided that a furnace is to be cut out, this can be done by connecting both

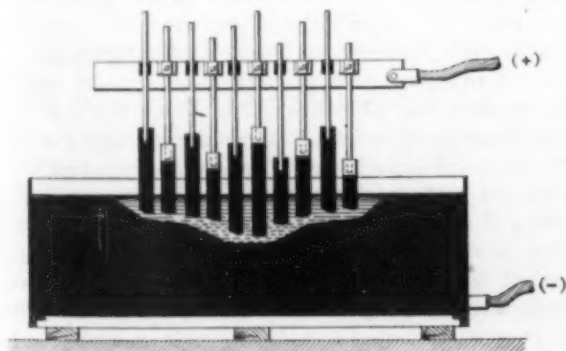


FIG. 23. HALL'S ORIGINAL FURNACE

the terminals to the bar or by using jumper connections. In this manner it is possible to short circuit a furnace and disconnect the same without disturbing the rest of the series. A new furnace can be cut in in the same manner, the electrodes may be lowered to the bottom

and the current in the series may be reduced until the new furnace is hot enough to melt the cryolite.

The temperature has also to do with the electrode consumption, and carbon monoxide is formed at high temperatures and burns with a blue flame, which also may be yellow on account of the sodium present. At ordinary temperatures between 800 and 1000 deg. C. carbon dioxide is also formed. The proportion of the volume of the waste gases varies from 5 to 10 and even up to 20 parts of carbon monoxide for 100,000 parts of carbon dioxide. It has, however, been proved that these gases are not dangerous to the operators in the furnace room.

The formation of the carbon dioxide occurs from the electrolysis of the dissolved alumina, and if all the alumina is decomposed the electrolysis may proceed with the aluminium fluoride. The fluorine forms then with the anode carbon tetrafluoride, a gas which is dissolved in water without being decomposed. This gas is, however, harmless. In any case, the furnace operator notices immediately when the alumina is consumed, as the furnace voltage rises from the normal 7 volts up to around from 15 to 17 and even up to 20 volts. The

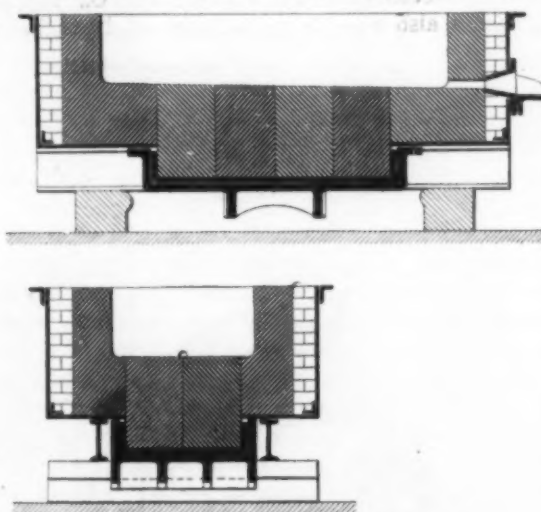


FIG. 24. LAMBERT'S FURNACE

incandescent lamp brightens up, the voltmeter needle swings over and the operator knows that more alumina must be added to the bath.

It has never been possible to find hydrofluoric acid in the gases from the aluminium furnaces. It was thought that hydrofluoric acid was the cause of the windows becoming dull, but when the bath or the electrodes contain some silica, the gases were found to contain about  $\frac{1}{10}$  per cent of silicon-tetrafluoride. This gas, due to the moisture in the air, will attack glass and make the windows dull; it also attacks copper in the neighborhood of the furnace and blackens it. The pine trees near the factory suffer also somewhat from the gases.

When a furnace gets "hot," for example over 1000 deg. C., a process takes place which is opposite to that which takes place when aluminium is produced. At higher temperatures the sodium fluoride of the bath is reduced, the sodium rises to the surface in small balls and burns with a lively yellow flame. With "hot" furnaces the aluminium will quickly dissolve the iron rakes which are used. A 900 to 950 deg. C. temperature of the bath seems to be the best, although some advocate

a lower temperature, 800 to 900 deg. C. The furnaces will then, however, be much more difficult to operate. Each operator can take care of from four to five furnaces.

Fig. 21 shows a frequently described furnace without carbon side linings. The intention is that the cryolite bath shall get hard and insulate the iron sides, but if it does not, the result is that there will be an iron content in the aluminium and the furnace may readily be damaged.

Fig. 22 shows how the negative terminal can be molded into the bottom mass. This construction is, however, used in only a few places.

Fig. 23 illustrates Hall's furnace, which, however, is of only historical interest commercially.

Fig. 24 is Lambert's furnace, the bottom of which consists of electrodes fitted into a cast-iron frame. This construction is still in use.

#### INDUSTRIAL APPLICATIONS OF ALUMINIUM

Aluminium can readily be cast and fills the molds well. When nearing its melting temperature it gets doughlike and contracts about 1.8 per cent in volume. By shaking it between 550 and 625 deg. C., it pulverizes. It is also generally resmelted if it is to be

larger and larger furnaces having capacities of several tons.

Aluminium can be resmelted without taking up gases and without forming blowholes, but it gets covered with a thin film of oxide. Its purity should not be less than 98 per cent, and if it is to be used for rolling,

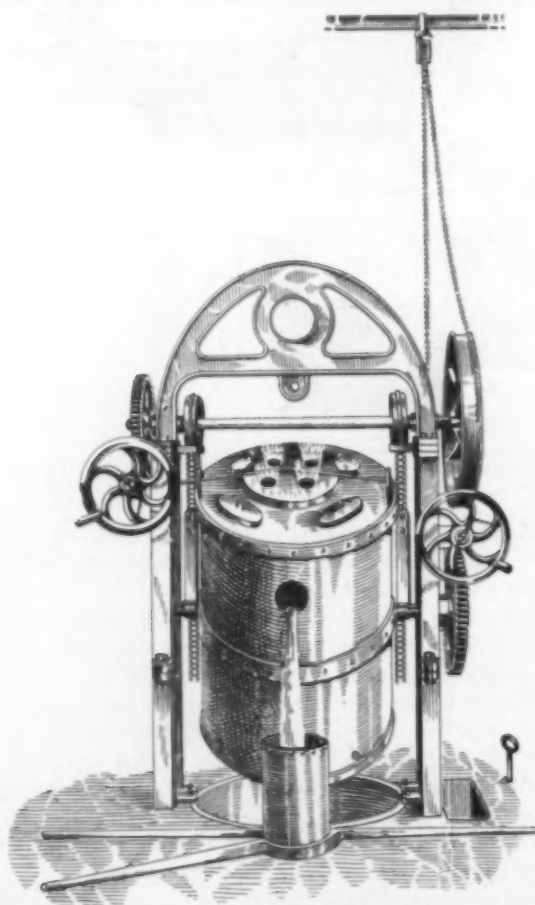


FIG. 25. ROUSSEU'S FURNACE

rolled or pressed, and the Rousseu furnace is widely used for this purpose, the construction being shown in Figs. 25 and 26. The retort is of graphite and the furnace is fired with coke. Plates up to 1.10 x 1.10 x 0.12 m, weighing from 300 to 400 kg. may be cast for use in rolling large sheets and the tendency is to construct

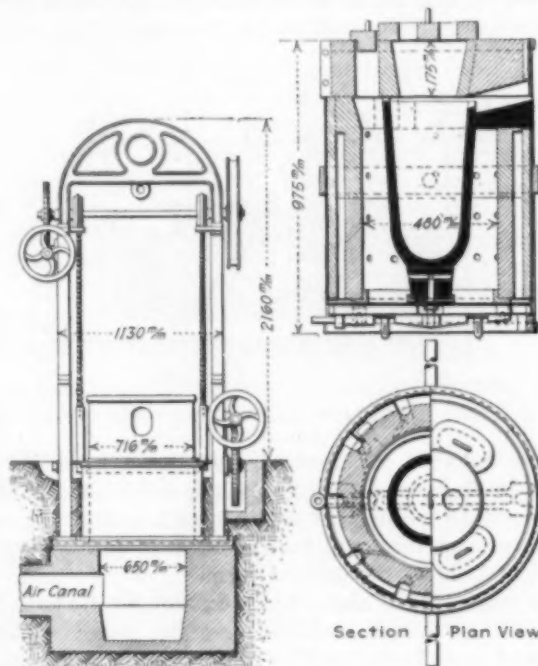


FIG. 26. CROSS-SECTIONS OF ROUSSEU'S FURNACE

where strength is essential, its purity should preferably be 99 per cent.

High-grade aluminium which does not contain more than  $\frac{1}{100}$  per cent sodium,  $\frac{1}{100}$  per cent iron and  $\frac{1}{2}$  per cent silica can be forged, rolled, drawn or punched, and can also be brazed and soldered. Aluminium may, therefore, take the place of tinfoil and in certain countries aluminium money is used instead of nickel. In America aluminium is extensively used for cans for fruit and other conservation, and in Sydney they use an aluminium alloy, called Ormiston, for this purpose entirely.

Aluminium is used in the form of sheets, pipes, cables or cast parts for automobiles, aeroplanes, etc., and pipes for carrying nitrous gases. Due to its lightness (2.7 against 8.9 for copper), its conductivity (34 against 57 for copper) and its comparative strength (22 against 44 for copper), aluminium is rapidly replacing copper in the electrical industry. To get the same conductivity only one-half the weight of aluminium is required as of copper. In reality aluminium is, therefore, twice as good a conductor as copper, when the conductivity is compared to the weight. As, furthermore, this one-half the weight of aluminium occupies a greater volume than copper, it follows that the heat radiation of a transmission line must be better than a copper line. An aluminium conductor can also better withstand the stress caused by its own weight, as its low specific weight in this case is of greater importance than its lower strength.

According to the law of Faraday, the production of 1 kg. aluminium requires 2969 amperes for one hour,



but in actual practice 5 to 10 per cent more is required. The voltage needed for the melting of the alumina is, according to Thomson, 2.8 volts, and from this must be subtracted the potential for the formation of the carbon dioxide and carbon monoxide, and to it must be added the potential corresponding to the resistance of the furnace and which heats the bath. In practice the total voltage is figured to be between 6.5 and 8.5 volts, but if extra long electrodes are used the voltage may be still higher. One kg. of aluminium has been produced with 25 kw.-hours, but 33-35 kw.-hours per kg. may be considered a good result.

The alumina consumption is theoretically 1.888 kg. per kg. aluminium and in practice 1.95 to 2 kg. The theoretical electrode consumption is 0.666 kg. or 0.333 kg. per electrode per kg. of aluminium, depending on how much carbon monoxide or carbon dioxide is formed. If the waste is subtracted, the consumption will go below 0.666 kg., which proves that carbon oxide is formed. An electrode consumption of from 0.7 to 0.9 kg. per kg. aluminium with a salvage of 0.2 to 0.3 kg. may be considered a good result.

#### COST

In order to give an idea of the various items which enter into the cost of manufacturing aluminium, the following tabulation has been prepared. It is, of course, greatly dependent on local conditions, and refers to normal conditions before the war:

Per Kg. Aluminium	Frs.
35 kw. hours at 0.7 centimes.....	0.25
2 kg. alumina at 0.25.....	0.50
0.3 kg. electrodes at 0.35.....	0.23
0.12 kg. cryolite at 0.40.....	0.05
0.05 kg. fluorine at 0.50.....	0.03
0.25 Working hours at 0.60.....	0.15
Miscellaneous .....	0.15
Total: Frs. ....	1.41

#### WORLD'S PRODUCTION OF BAUXITE (TONS)

Country	1913	1915	1917
United States .....	210,241	297,041	568,690
France .....	304,314	.....	.....
United Kingdom .....	8,282	11,723	14,724
Italy .....	6,841	5,807	.....
India .....	1,184	876	.....
	530,862		

By this table it will be seen that the United States is assuming a leading position in the production of bauxite.

## Industrial Reconstruction in Great Britain

ON NOV. 12 last, one day after the armistice was signed, a Parliamentary paper was issued in London announcing the appointment of an Advisory Council and other councils and committees by the Minister of Reconstruction. The Advisory Council consists of a panel of men and women of mature experience and distinction in affairs. It is divided into five sections, each of which meets once a week. Their purpose is to advise on questions of special difficulty or complexity that may come before the Ministry. An informal committee of women members of the Council will meet regularly to give advice as desired in connection with questions affecting the position of women. The five sections relate respectively to (1) Finance, Transport and Common Services, (2) Production and Commercial Organization, (3) Labor and Industrial Organization, (4) Rural Develop-

ment, including Agriculture, and (5) Social Development, including Health, Education and Housing.

Another Council was appointed which has to do with the disposal of surplus Government property.

The Engineering Trade Committee is also a creation of the Minister of Reconstruction, and its purpose is "to compile a list of the articles suitable for manufacture by those with engineering trade experience or plant which either were not made in the United Kingdom before the war but were imported or were made in small or insignificant quantities in the United Kingdom and for which there is likely to be a considerable demand after the war." These are classified as to whether they are capable of being made by women, or by men and women, or by skilled men. The committee is to set forth where such industries may be most suitably attached, to make recommendations on their establishment and development by transfer of labor and machines or otherwise, and how such transfers may be made, as well as what organization is requisite with due regard to securing the coöperation of labor.

In this connection the following branch committees have been appointed: Wire Machinery, Printing Machinery, Printers' General Machinery, Papermaking Machinery, Leather Manufacturing Machinery, Textile Machinery (one in Manchester and one in Nottingham), Machine Tools, Agricultural Machinery, Aircraft, Hollow-ware and Sheet Metal and Pressed Work (one committee), Electrical Apparatus, Scientific Instruments, Miscellaneous Machinery and a General Labor Panel.

Still another series of committees has been appointed to consider and report upon the nature and amount of the supplies and foodstuffs required by the United Kingdom between the close of the war and the restoration of normal conditions, having regard to the requirements of India, the Dominions and Crown Colonies, the probable requirements of belligerents and neutrals at the close of hostilities, the sources from which they may be obtained and whether any measure of control will need to be exercised, as well as the measure and extent of such control. These committees consist of ten bodies and will consider respectively aluminium, antimony, copper, lead, nickel, spelter, tin, ferro-alloys, asbestos and hides and skins.

A committee is appointed to inquire into the extent that building materials will be needed and to ascertain how and where they are to be procured.

A large committee of many members considers priority after the war. This is composed of employers and workmen and is already at work.

The Committee on Interim Industrial Relations proposed that in each industry which has reached a sufficient level of organization there be established a Joint Industrial Council, consisting of equal numbers of representatives of associations of employers and members of trade unions which shall be approved by the Government. A considerable number of such councils have been formed and the Minister of Reconstruction will consult them on questions affecting their respective industries. A still greater number are in process of organization. In regard to heavy chemicals a Joint Industrial Council has been set up which is represented on this special committee. It was formed at the suggestion of the Minister of Reconstruction to deal with technical and commercial questions falling outside the scope of the council.

## Graphic Method for Fortification of the Spent Acids Used in Making Nitrating Mixed Acids

BY D. LOPEZ AND A. A. SWANSON

THE USE of mixtures of sulphuric and nitric acids of definite composition, so-called "mixed acids" in the manufacturing processes, especially in the explosive industry, has steadily increased. The chemist has been called upon to make unlimited numbers of calculations in his work of revivifying the spent acid recovered from the nitration. Work of this nature becomes more or less involved; it is necessary to have available methods which permit of easy and rapid solution of acid problems and which possess a high degree of accuracy.

It is hoped that the brief theoretical development of the principles involved in the fortification of spent acids and their use graphically, as given in this paper, will arouse interest in this field particularly at this time and find favor among acid-control chemists.

In a mixed acid let:

N = lb. of HNO<sub>3</sub> in 1000 lb. of mixed nitrating acid;

S = lb. of H<sub>2</sub>SO<sub>4</sub> in 1000 lb. of mixed nitrating acid;

W = lb. of H<sub>2</sub>O in 1000 lb. of mixed nitrating acid;

N<sub>s</sub> = lb. of HNO<sub>3</sub> in 1000 lb. of spent mixed acid;

S<sub>s</sub> = lb. of H<sub>2</sub>SO<sub>4</sub> in 1000 lb. of spent mixed acid;

W<sub>s</sub> = lb. of H<sub>2</sub>O in 1000 lb. of spent mixed acid;

so that:

N + S + W = 1000 lb. of mixed nitrating acid;

N<sub>s</sub> + S<sub>s</sub> + W<sub>s</sub> = 1000 lb. of spent mixed acid.

The following symbols shall be used:

x = lb. of HNO<sub>3</sub> added to revivify 1000 lb. of spent mixed acid;

y = lb. of H<sub>2</sub>SO<sub>4</sub> added to revivify 1000 lb. spent mixed acid;

z = lb. of H<sub>2</sub>O added to revivify 1000 lb. spent mixed acid;

X = lb. of HNO<sub>3</sub>Aq. added to revivify 1000 lb. spent mixed acid;

Y = lb. of H<sub>2</sub>SO<sub>4</sub>Aq. added to revivify 1000 lb. spent mixed acid;

P<sub>s</sub> = Per cent HNO<sub>3</sub> in HNO<sub>3</sub>Aq. used;

P<sub>n</sub> = Per cent H<sub>2</sub>SO<sub>4</sub> in H<sub>2</sub>SO<sub>4</sub>Aq. used;

x = P<sub>s</sub>X;

y = P<sub>n</sub>Y;

F = (1000 + X + Y) lb. of refortified mixed acid;

W<sub>r</sub> = lb. of water in F lb. of refortified mixed acid;

(N<sub>s</sub> + x) + (S<sub>s</sub> + y) + W<sub>s</sub> + z = F.

This new mix will be equivalent to the required mixed acid composition when:

$$N_s + x = \frac{NF}{1000}; S_s + y = \frac{SF}{1000}; W_s + z = \frac{WF}{1000}$$

$$\frac{N_s + x}{N} = \frac{S_s + y}{S} = \frac{W_s + z}{W} \quad (1)$$

Substituting for x, y and z in equation 1, we obtain

$$\frac{N_s + P_s x}{N} = \frac{S_s + P_n y}{S} = \frac{W_s + z}{W} = \frac{W_2}{W} \quad (2)$$

The water introduced (z) in adding the refortifying acids to 1000 lb. of spent acid may be expressed by the following equation:

$$Y(1 - P_n) + X(1 - P_s) = z = W_2 - W_s \quad (3)$$

by transposition,  $P_n X = Y(1 - P_n) + X - W + W_s$ ,

and substituting for P<sub>n</sub>X in the nitric ratio in equation 2 we have:

$$\frac{N_s + Y(1 - P_n) + X - W_2 + W_s}{N} = \frac{W_2}{W}$$

transpose -W<sub>2</sub> to the right and simplify,

$$\frac{N_s + W_s + Y(1 - P_n) + X}{N} = \frac{W_s}{W} + \frac{W_2}{N} = \frac{W_2(N + W)}{NW}$$

cancel N from the denominators and transpose N + W, to obtain the equation:

$$\frac{N_s + W_s + Y(1 - P_n) + X}{N + W} = \frac{W_2}{W} \quad (4)$$

If the term P<sub>n</sub>, the per cent H<sub>2</sub>SO<sub>4</sub> in the H<sub>2</sub>SO<sub>4</sub>Aq. to be used in mixing, is assumed to be a constant in

equations 4 and 5 obtained by referring  $\frac{W_2}{W}$  to equation 2,

$$\frac{S_s + P_n Y}{S} = \frac{W_2}{W} \quad (5)$$

it is readily seen that equation 4, on account of the presence of the variable parameter W<sub>2</sub>, represents a system of straight lines parallel to each other. By similar reasoning it is seen that equation 5 represents another system of straight lines which are parallel to the X axis. By combining equations 4 and 5, we can eliminate

the common term  $\frac{W_2}{W}$  and get an equation which is the

locus of all the points in which the systems 4 and 5 intersect. This locus is represented by the equation:

$$Y[P_n(N + S + W) - S] - SX + S_s(N + W) - S(N_s + W_s) = 0,$$

and by rearranging and substituting, with T and H,

$$\frac{P_n(N + S + W) - S}{S} = T$$

$$\frac{S_s(N + W) - S(N_s + W_s)}{S} = H$$

the equation becomes TY - X + H = 0 (6)

In equation 6, Y gives the amount of sulphuric acid of fixed strength P<sub>n</sub>, and X the corresponding amount of nitric acid of unknown (P<sub>n</sub>) concentration. The determination of this develops as follows: By eliminating Y from the sulphuric ratio in equation 2 with the equivalent of Y from equation 3 we obtain:

$$\frac{S_s + P_n Y}{S} = \frac{W_2}{W} \quad (2)$$

$$Y = \frac{W_2 - W_s - X(1 - P_n)}{1 - P_n} \quad (3)$$

$$\frac{W_2}{W} = \frac{S_s + \frac{P_n[W_2 - W_s - X(1 - P_n)]}{1 - P_n}}{S}$$

$$= \frac{S_s(1 - P_n) + P_n W_2 - P_n[W_s + X(1 - P_n)]}{S(1 - P_n)}$$

$$\frac{W_2}{W} (1 - P_n) S - P_n W_2 = S_s(1 - P_n) - P_n[W_s + X(1 - P_n)]$$

$$\frac{W_2}{W} = \frac{S_s(1 - P_n) - P_n[W_s + X(1 - P_n)]}{S(1 - P_n) - W P_n}$$

$$\frac{N_s + W_s + Y(1 - P_n) + X}{N + W} = \frac{S_s + P_n Y}{S}$$

Transposing the terms to the right member

$$N P_n Y + W P_n Y - S Y(1 - P_n) - S X + S_s N + S_s W - S N_s - S W_s = 0$$

$$Y[P_n(N + S + W) - S] - S X + S_s(N + W) - S(N_s + W_s) = 0,$$

Since (N + S + W) is always equal to 1000 and S and P<sub>n</sub> are constant; T, the tangent of the angle intercepted by the horizontal axis and the curve, must also be a constant. H, the intercept of the vertical axis, is usually positive, but the system is not altered when it is negative.



In order to eliminate the term  $\frac{W_2}{W}$  and obtain a function in  $P_n$  and  $X$ , we substitute for it the nitric ratio from equation 2:

$$\frac{N_s + P_n X}{N} = \frac{S(1 - P_n) - P_n[W_s + X(1 - P_n)]}{S(1 - P_n) - WP_n}$$

Transposing and clearing of fractions,

$$\begin{aligned} NS_s(1 - P_n) - NP_n W_s - NP_n X + NP_n XP_n - \\ N_s[S(1 - P_n) - WP_n] - P_n X[S(1 - P_n) - \\ WP_n] = 0. \\ NP_n P_n X - [S(1 - P_n) - P_n W]P_n X - NP_n X + \\ N[S_s(1 - P_n) - P_n W_s] - N_s[S(1 - P_n) - \\ P_n W] = 0. \end{aligned}$$

$$\frac{P_n X[P_n(N + S + W) - S]}{NP_n} - X + \frac{N[S_s - P_n(S + W_s)] - N_s[S - P_n(S + W)]}{NP_n} = 0$$

This equation can be condensed by substituting for the expressions

$$\begin{aligned} \frac{P_n(N + S + W) - S}{NP_n} &= A \\ \frac{N[S_s - P_n(S + W_s)] - N_s[S - P_n(S + W)]}{NP_n} &= C \\ P_n X A - X + C &= 0. \end{aligned} \quad (7)$$

This equation, the locus of the  $P_n$  values corresponding

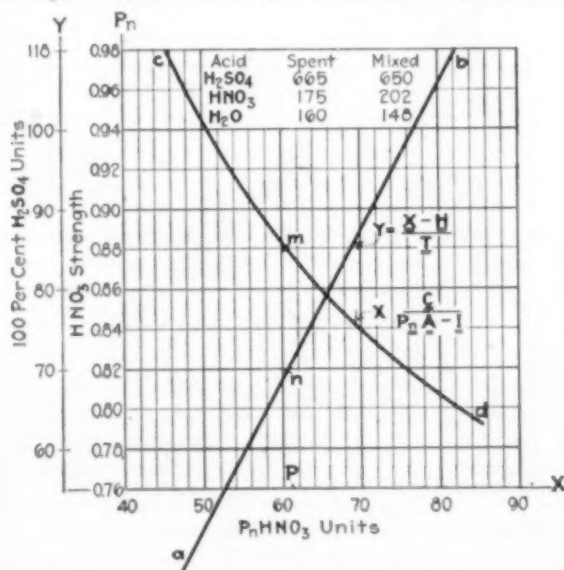


CHART I. CURVES FOR BUILDING UP 665-175-160 SPENT ACID TO 650-202-148 MIXED ACID WITH 100 PER CENT  $H_2SO_4$  0.8-0.98  $HNO_3$

to the various values of  $X$ , gives a hyperbolic curve having the following characteristics:

1. The  $P_n$  axis is asymptotic to the curve.
2. The other asymptote is  $Y = \frac{1}{A}$  and is therefore parallel to the  $X$  axis.
3. The negative values, although giving a solution, mean nothing in practice. All practical values of the curve are in the first quadrant. This curve (7) shall be called the "Curve of the Nitric Acid Strength."

A chart can be plotted from equation 6 and 7.

$$Y = \frac{X - H}{T} \quad (6)$$

$$X = -\frac{C}{P_n A - 1} \quad (7)$$

Equation 7 is used for plotting the curve  $cd$  in chart I, giving for each value of  $P_n$  the corresponding value of  $X$ , and equation 6 the curve  $ab$  in Chart I, using the

values of  $X$  obtained from the equation. Referring to equations 6 and 7 in their original form, it is seen that the terms  $T$ ,  $H$ ,  $A$  and  $C$  have the following values after arrangements and reductions:

$$T = \frac{1000P_n - S}{S}$$

$$H = \frac{1000S_s}{S} - 1000$$

$$A = \frac{1000P_n - S}{NP_n}$$

$$C = \frac{N_s}{N} \left( 1000 - \frac{S}{P_n} \right) - \left( 1000 - \frac{S_s}{P_n} \right)$$

If  $P_n$  is assumed to equal 1, the relations become,

$$T = \frac{1000}{S} - 1$$

$$H = \frac{1000S_s}{S} - 1000$$

$$A = \frac{1000 - S}{N}$$

$$C = \frac{N_s}{N} (1000 - S) - (1000 - S_s)$$

Let a spent acid have the following proportions per 1000 pounds:

$S_s = 665$  (Analysis 66.5 per cent)

$N_s = 175$  (Analysis 17.5 per cent)

$W_s = 160$  (Analysis 16 per cent)

and the required mixed acid:

$S = 650$  (Analysis 65 per cent)

$N = 202$  (Analysis 20.2 per cent)

$W = 148$  (Analysis 14.8 per cent)

By substituting these values, we have:

$$T = 0.5385$$

$$H = 23.076$$

$$A = 1.7327$$

$$C = -31.78$$

By equation 9 giving to  $P_n$  values varying between 0.80 and 0.98 and substituting in expression 8 the values resulting for  $X$ , we obtain the values computed in the following table:

$P_n$	$X$	$Y$
0.80	82.33	110.00
0.82	75.56	.....
0.84	69.81	.....
0.86	64.88	.....
0.88	60.60	.....
0.90	56.85	.....
0.92	53.54	.....
0.94	50.39	.....
0.96	47.95	.....
0.98	45.57	41.77

$$H = \frac{S_s(N + W) - S(N_s + W_s)}{S}$$

by adding and subtracting  $\frac{S_s S}{S}$ , we have

$$\begin{aligned} H &= \frac{S_s N + S_s W + S_s S - S N_s - S W_s - S S_s}{S} \\ &= \frac{S_s(N + W + S) - S(N_s + W_s + S_s)}{S} \end{aligned}$$

As  $N + W + S$  and  $N_s + W_s + S_s = 1000$

$$H = \frac{1000S_s - 1000S}{S} = \frac{1000S_s}{S} - 1000$$

$$C = \frac{NS_s - NP_n(S + W) - N_s S + N_s P_n(S + W)}{NP_n}$$

by adding and subtracting  $\frac{N_s P_n N}{NP_n}$  we have

$$\begin{aligned} &= \frac{NS_s - NP_n S_s - NP_n W_s - NP_n N_s + N_s S + N_s P_n S + N_s P_n W + N_s P_n N}{NP_n} \\ &= \frac{N_s P_n(S + N + W) - N_s S - NP_n(S_s + N_s + W_s) + NS_s}{NP_n} \\ &= \frac{N_s}{N} \left( 1000 - \frac{S}{P_n} \right) - \left( 1000 - \frac{S_s}{P_n} \right) \end{aligned}$$

On a rectangular axis system XY, Chart I, trace a vertical line parallel to the y axis, denote this the  $P_n$  axis, and mark on it the strengths 0.98, 0.96, 0.94, etc., of the nitric acid. If parallels to the X axis are drawn through those points, intersecting parallels to the Y axis drawn through the values of X, a line drawn through the points of intersection will give the curve  $cd$ , Chart I, represented by equation 9.

Repeating the same operation with points  $X = 82.33$ ,  $Y = 110$ ,  $X = 45.57$ ,  $Y = 41.72$ , and uniting them by a straight line we obtain the curve  $ab$ , Chart I, represented by equation 8.

#### USE OF CHART I

Suppose that nitric acid of 88 per cent strength is available and that the spent and mixed acids are of strengths above mentioned, then in order to get the amounts in units of sulphuric and nitric necessary to build up the spent acid we proceed as follows:

At the point marked 88 per cent on Chart I, follow horizontally until intersecting the curve line  $cd$ , at  $m$ , from this point drop down parallels to the Y axis intersecting the straight line  $ab$ , and X the axis in  $n$  and  $p$  respectively; the first intersection  $n$  gives in the sulphuric acid scale the amount of 100 per cent sulphuric, and the second intersection gives the amount of nitric acid.

In the above instance the readings are as follows:

$X = 60.60$  units;

$Y = 69.68$  units;

Total = 130.28 units;

Spent acid used 1000.00 units;

Total mix made = 1130.28 units.

60.6 units of 88% $\text{HNO}_3$ contains	{	$\text{HNO}_3$	53.33 units
		$\text{H}_2\text{O}$	7.27 units
1000 units of spent acid contains	{	$\text{HNO}_3$	175.00 units
		$\text{H}_2\text{O}$	160.00 units
and the total mix contains	{	$\text{HNO}_3$	228.33 units
		$\text{H}_2\text{O}$	167.27 units

therefore the percentage strength of the resulting mix is:

$$\frac{228.33}{1130.28} = 20.201 \text{ per cent } \text{HNO}_3$$

$$\frac{167.27}{1130.28} = 14.799 \text{ per cent } \text{H}_2\text{O}$$

Should other strengths of nitric than 88 per cent be used the same outline could be followed.

#### FORTIFYING ACIDS

Observing the curve  $ab$ , Chart I, it is readily seen that each point represents a mixture of sulphuric and nitric acids of definite strength and in definite amounts. Now these mixtures, high in nitric and low in water, are called fortifying acids, and can be obtained by reading the amounts on the chart and computing its composition. This method is both tedious and long. In the work that follows, the solution of this important part of the problem has been simplified.

Suppose that the nitric to be used is taken as X, and the sulphuric as Y, therefore, if it were desired to make 1000 units of this mixture, the amount of nitric to be used is represented by the ratio

$$X_{1000} = \left( \frac{X}{X+Y} \right) 1000$$

and the sulphuric by the ratio

$$Y_{1000} = \left( \frac{Y}{X+Y} \right) 1000$$

Substituting the values of X and Y from equations 8 and 9

$$X_{1000} = \frac{\left( \frac{C}{AP_n - 1} \right) 1000}{\frac{C}{AP_n - 1} + \frac{C}{AP_n - 1} - H} = \frac{\left( \frac{C}{AP_n - 1} \right) 1000}{\frac{TC + C - H(AP_n - 1)}{T(AP_n - 1)}} \\ = \frac{(TC)1000}{(T+1)C - H(AP_n - 1)} \quad (10)$$

applying the same process.

$$Y_{1000} = \frac{[C - H(AP_n - 1)]}{(T+1)C - H(AP_n - 1)} \quad (11)$$

Now on to the assumption that  $X_{1000} + Y_{1000} = 1000$ , it will only be necessary to calculate one of the expressions and deduct the others by subtracting from 1000.

In order to simplify calculations allow for  $P_n$  constant variations and compute the resulting differences for

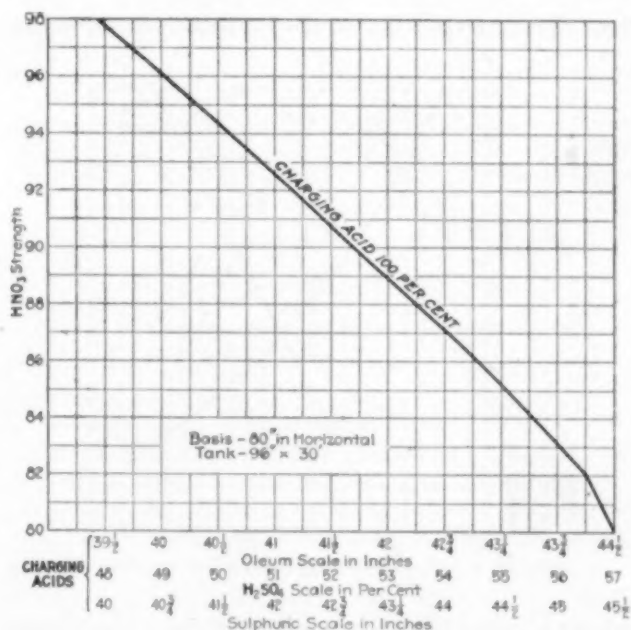


CHART II. CHART FOR MAKING FORTIFYING ACID WITH 104 PER CENT OLEUM OR 95 PER CENT  $\text{H}_2\text{SO}_4$

$H(AP_n - 1)$  when  $P_n$  takes the values  $P_{n1}, P_{n2}, \dots$  as follows:

$$H(AP_{n1} - 1) - H(AP_{n0} - 1) = HAP_{n1} - H - HAP_{n0} + H = (P_{n1} - P_{n0})HA$$

consequently if  $V_1, V_2, \dots$  are the different values for  $H(AP_n - 1)$  we have

$$V_0 = H(AP_{n0} - 1);$$

$$V_1 = H(AP_{n0} - 1) + HA(P_{n1} - P_{n0});$$

$$V_2 = V_1 + HA(P_{n2} - P_{n1});$$

$$V_3 = V_2 + HA(P_{n3} - P_{n2});$$

$$V_n = V_{n-1} + HA(P_{nn} - P_{nn-1}).$$

The values for  $X_{1000}$  and  $Y_{1000}$  computed from equation 10 are given in the following table and have been used for plotting the curve, Chart II, for the making of fortifying acids.



$P_n$	$X_{1000}$	$Y_{1000}$
0.80	42.83	57.17
0.82	43.69	56.31
0.84	44.60	55.40
0.86	45.55	54.45
0.88	46.54	53.46
0.90	47.58	52.42
0.92	48.66	51.34
0.94	49.79	50.21
0.96	50.98	49.02
0.98	52.22	47.78

To simplify drawing of curve even figures have been assumed in some instances.

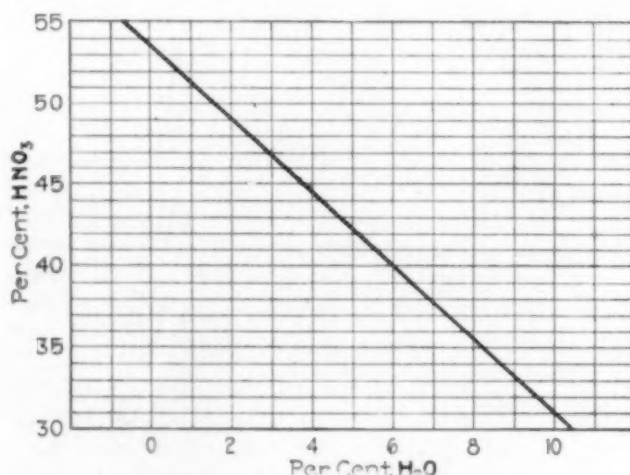


CHART III. FORTIFYING ACID CURVE

For practical purposes when  $P_n$  changes from a value of 1.00, say 0.95 to 1.05, corrections are to be made as follows:

$P_n > 1$  correction equals  $-(P_n - 100)$ ;

$P_n < 1$  correction equals  $+(100 - P_n)$ .

Usually when doping a spent acid with fortifying acid the calculations are based on the water and nitric content. It is necessary, therefore, to have an exact relation existing between those components in the fortifying acid. This phase is developed as follows:

Equation 10 gives the amount in units of nitric acid of strength to make 1000 units of fortifying mixture, therefore the 100 per cent nitric acid contained in  $X$  units will be,

$P_n X$ , or according to equation 10,

$$P_n X_{1000} = \frac{P_n TC 1000}{(T+1)C - H(AP_n - 1)} = N \quad (12)$$

and the water per cent will be,

$$W = X_{1000} - N = \frac{(TC)1000 - (P_n TC)1000}{(T+1)C - H(AP_n - 1)} \quad (13)$$

Eliminating  $P_n$  in equations 12 and 13 we obtain,

$$N = \frac{(TC)1000}{(T+1)C - H(A-1)} - \frac{[(T+1)C + H]1000}{(T+1)C - H(A-1)} \times W \quad (14)$$

#### DERIVATION OF CHART III

Equation 14 is the locus of all fortifying acids that, with the spent acid considered, will make the nitrating mixed acids come within the specified limits in component strengths. Its form and degree are those of a straight line, very easy to plot. Take, for instance,

two points corresponding to the values  $W = 0$  and  $W = 100$ , then  $N = 533$  and  $310$  respectively. These two points are sufficient for plotting the straight line, Chart III.

This O.K. fortifying acid curve can also be constructed by another method. Let  $D_N$  and  $D_W$  be the differences in amounts of the nitric acid and water between the nitrating and the spent acids. Let  $N_F$ ,  $W_F$ ,  $N$  and  $W$  be the nitric acid and the water in 1000 lb. of fortifying acid and the nitrating acid respectively. Let  $F$  equal the amount of fortifying to be used in order to obtain in  $A_s$  units of spent acid the increase  $D_N$  in nitric and the decrease  $D_W$  in the water. Therefore,

$$D_W = \frac{(W - W_F)}{A_s} F \text{ and } D_N = \frac{(N_F - N)}{A_s} F$$

$$\frac{D_N}{D_W} = \frac{N_F - N}{W - W_F}; \text{ now if to } W_F \text{ the values } 0, 1, 2, \dots$$

be given we get the corresponding values for  $N_F$ . Since this equation is that of a straight line, two points are sufficient for constructing the curve.

#### CHART FOR MAKING NITRATING MIXES

Let the amount of spent acid used for fortification equal  $A_s$ , and the amount of fortifying acid necessary equal  $F$ ,  $W_s$  = the water in the spent acid and  $W_F$  = the water in the fortifying acid and  $W$  = the water in the nitrating acid, then we have,

$$A_s W_s + F W_F = (A_s + F) W = A_s W + F W.$$

Therefore,  $A_s(W_s - W) = F(W - W_F)$ , and finally,

$$W_s - W = F \frac{(W - W_F)}{A_s} \quad (15)$$

In this equation  $W_s - W$  expresses the difference in water to be obtained by the addition of fortifying acid of definite content  $W_F$ , consequently if we assign values to  $W_F$  of 0, 1, 2, ...,  $n$  we get in each case the equation of a straight line of the Form  $Y = aX$ , all having the same origin. Now if we give to  $A_s$  the particular value 1000,  $F$  will represent in each case the amount of fortifying acid to be used for each 1000 units of spent acid for getting the reduction in water equal to  $(W_s - W)$ . If instead of the water, we consider the nitric acid, we will realize that we ought to have an increase in the percentage of nitric and then the equation would become,

$$N - N_s = \frac{(N_F - N) F}{A_s} \quad (16)$$

and this equation has the same properties as equation 15.

The construction of the chart then follows.

Take a vertical axis upon which we will count the  $F$  values, give values to  $A_s$  equal 1000,  $W_F = 0, 1, 2, 3, \dots, n$  and take  $(W_s - W) = 10$  construct on the left hand side the resulting radial straight lines.

Assigning to  $N_F$  values between 250 and 500 make  $(N - N_s) = 30$ , then construct the lines on the right hand side of the axis Chart IV. The accuracy of the chart depends on the scale used.

Several instances showing the simplicity of its uses will be developed.

First—Computation of the O.K. fortifying acid nec-

essary to make a nitrating mixed acid by fortifying spent acid. Take for instance,

Water in the spent acid, . . . 16.00 per cent  
Water in the mixed acid, . . . 14.80 per cent  
Water to be reduced, . . . . . 1.20 per cent  
Water in the fortifying acid, 6.00 per cent

#### Procedure:

Follow the water line marked 6 per cent until intersection of the vertical line marked 1.20 per cent. From this point go horizontally until intersection of vertical axis at a point reading 14,000 (see Chart IV). This means that for each 1000 units of spent acid we shall add 140 units of fortifying acid. Regarding the nitric content, we assume that it will adjust itself automatically within the specified limits, since the fortifying acid used is an O.K. one.

#### Second—

Spent acid  $\left\{ \begin{array}{l} \text{H}_2\text{O} = 16.40 \text{ per cent} \\ \text{available HNO}_3 = 17.30 \text{ per cent} \end{array} \right.$   
Mixed acid to be made  $\left\{ \begin{array}{l} \text{H}_2\text{O} = 15.10, = 0.05 \\ \text{HNO}_3 = 20.00, = 0.50 \end{array} \right.$   
Fortifying acid to be used  $\left\{ \begin{array}{l} \text{H}_2\text{O} = 5.00 \\ \text{HNO}_3 = 44.00. \end{array} \right.$

Water is to be reduced 1.30, nitric to be increased 2.70 to 3.20 per cent.

Chart IV gives on the line 5 per cent and that corresponding to the water reduced 1.30 per cent, 13,500, or 135 fortifying acid units for 1000 units of spent acid. The increasing nitric acid will be taken according to the reading on the chart, upon the same line, 135 and line 44 per cent and equals 3.20 per cent. Then the resulting mixed acid should be

$\text{H}_2\text{O} = 16.40 - 1.30 = 15.10 \text{ per cent}$   
 $\text{HNO}_3 = 17.30 + 3.20 = 20.50 \text{ per cent}$

Third—To determine the percentage composition of water and nitric in the spent acids.

Fortifying acid used in making mixed acid,

$\text{H}_2\text{O} = 4.50 \text{ per cent}$   
 $\text{HNO}_3 = 44.50 \text{ per cent}$

Mixes obtained with this fortifying analyzed as follows:

No. of Mines	Per Cent $\text{H}_2\text{O}$	Per Cent $\text{HNO}_3$
1	15.15	20.30
2	15.20	20.26
3	15.18	20.46
4	15.12	20.20
5	15.22	20.35
Mean	15.17	20.31

Ratio between spent acid and fortifying acid used,

$\frac{A_s}{F} = \frac{12}{100}$  then Chart IV gives,

Water reduced = 1.22 per cent;  
Nitric increased = 2.90 per cent;  
consequently the spent acid had,  
 $\text{H}_2\text{O} = 15.17 + 1.22 = 16.39 \text{ per cent.}$

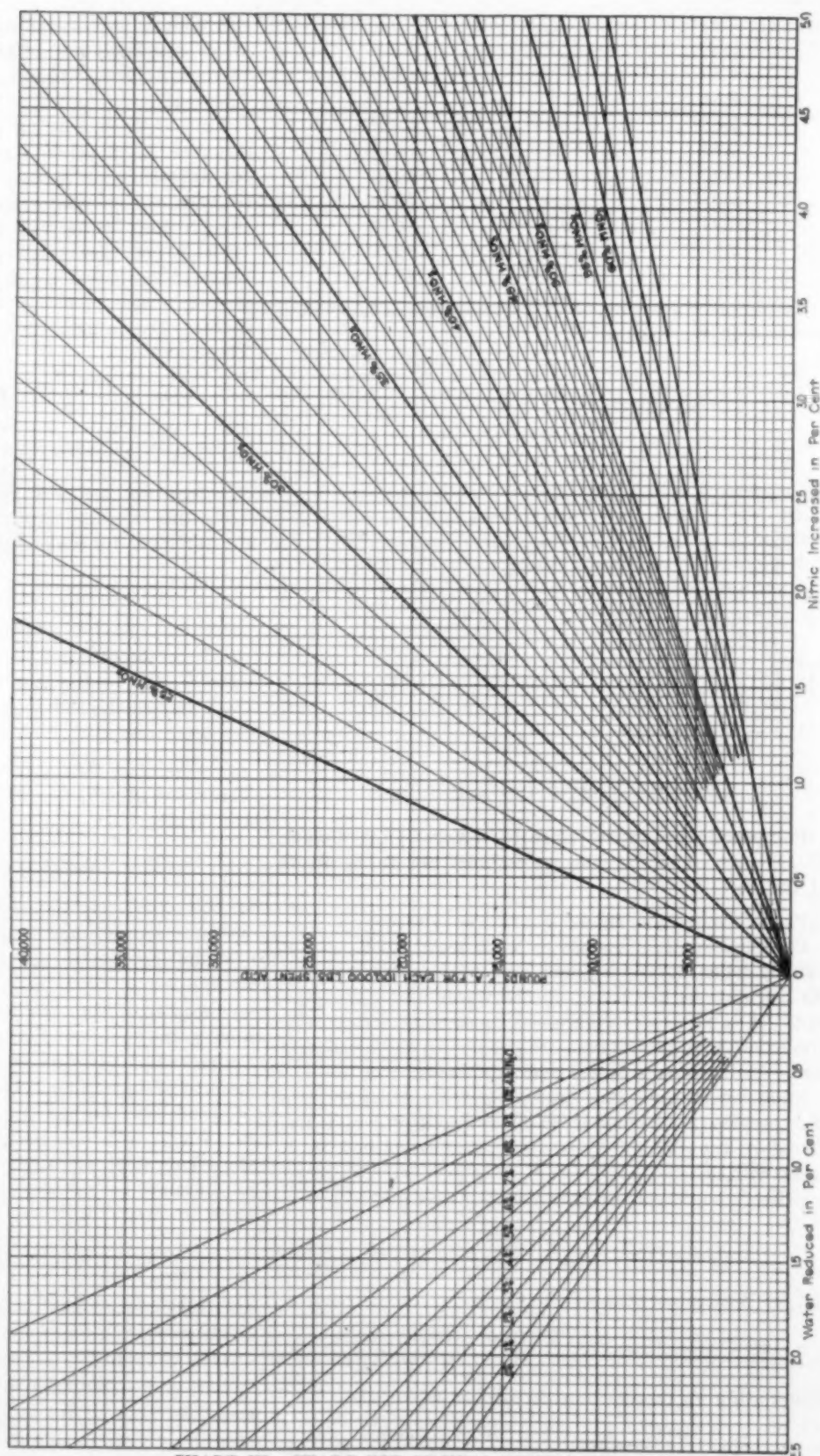


CHART IV. CHART FOR MAKING MIXED ACIDS



Fourth—Use of two fortifying acids of different composition, one strong in "nitric" and the other weak.

Strong Fortifying Acid	$\left\{ \begin{array}{l} \text{H}_2\text{O} = 7 \text{ per cent} \\ \text{HNO}_3 = 45 \text{ per cent} \end{array} \right.$
Weak Fortifying Acid	$\left\{ \begin{array}{l} \text{H}_2\text{O} = 5 \text{ per cent} \\ \text{HNO}_3 = 40 \text{ per cent} \end{array} \right.$

We want to reduce the water by 1.20 per cent and increase the nitric 2.90 per cent. Applying the chart for both separately we have:

Strong—Water reduced 1.20 per cent, nitric increase 3.83 per cent;

Weak—Water reduced 1.20 per cent, nitric increase 2.43 per cent.

Difference in "plus" =  $3.83 - 2.90 = +0.93$  per cent in the first.

Difference in "minus" =  $2.90 - 2.43 = -0.47$  per cent in the second, according with those differences we can see that by using two parts of the weak fortifying acid we can balance the surplus in nitric made by using one part of the strong, or in other words, we can reduce the water 0.40 per cent by using 5250 pounds of the fortifying acid with 7 per cent water (see Chart IV) and 0.80 per cent by using 8250 pounds of the fortifying acid with 5 per cent water.

Some of the mixes made up in the mixing house require small corrections to bring them within the fixed limits of nitric acid and water content respectively. These corrections can also be computed with the aid of Chart IV.

Let the fortifying acid in use be  $W_F$  per cent  $\text{H}_2\text{O}$ . Take on the central scale Chart IV the point marked 10,000; the intersections along this 10,000 line with the water straight lines will give in each case the effect obtained by the addition of that amount of fortifying acid in 100,000 units of spent acid; now if in each case we place the decimal one place to the left we will get the effect of a thousand units in 100,000 units of mixed acid. Take, for instance, water = 5 per cent and read on the intersection of this line with the 10,000 line the reading is 0.96. Make the decimal one place to the left and we get the correction .096 per cent. The correction computed by other methods for mixer containing 14.50 per cent to 15.50 per cent water is between 0.094 and 0.10 of 1 per cent. Several arrangements can be used for definite amounts of mixed acid other than 100,000 pounds. We will take two instances. First, horizontal tanks containing 150,000 pounds mixed acid, and, second, vertical tanks containing 300,000 pounds. In the first case the effect obtained with the addition of 1000 pounds of fortifying acid on 100,000

pounds mixed is in the ratio of  $\frac{100}{150} = 0.67$ ; consequently if we mark the line corresponding to 6700 pounds on the chart we will obtain the corrections by direct reading without further calculation. In the second case there is always a definite ratio between the "dip" in inches and the content in pounds, so, assuming that one inch represents 2300 pounds mixed acid, we can compute the effect of one inch fortifying acid as follows:

Correction obtained by 1000 pounds fortifying acid on 100,000 pounds mixed = C.

Correction obtained by 2300 lb. fortifying and in 300,000 is equal to 0.77 C, development as follows: correction obtained by adding 1000 lb. to 100,000 lb. = C.

The effect produced by the same addition to 300,000 lb. is equal to  $\frac{C}{3}$  and, therefore when the addition is

2300 lb. the correction becomes  $\frac{2.3 \times C}{3} = 0.77C$ .

Consequently you draw a line on the line 7.700 pounds and read, placing decimal one point to the left and get the corrections without any further calculations.

Nitro, West Virginia.

## Safe Load on I-Beam by Rule of Thumb

BY JOHN S. CARPENTER

WHEN installing new machinery or taking out old, it is often desirable to use a block and tackle. Such rigging must be attached to beams, which usually may be found around power plants and may be arranged so that they are directly over the load. In a case of this kind it is desirable to know just what safe load may be put on the beam. A rule of thumb that will give this information is as follows:

Multiply the weight per foot of the I-beam by the depth in inches and divide the product by the span in feet. The result is the safe load in thousands of pounds for a uniformly distributed load. For a single load in the center of the span, take half the foregoing result.

To the writer, who has always figured beams by the usual bending-moment formulæ, this rule did not sound right. It seemed too good to be true. So he determined to prove it to his own satisfaction. Let

$W$  = Safe uniform load in pounds;

$L$  = Span in feet;

$S$  = Section modulus;

$s$  = Safe stress, 16,000 lb. per sq.in.;

$w$  = Weight of beam per foot;

$d$  = Depth of beam in inches.

According to the rule, then,  $W = \frac{1000wd}{L}$ . But for a beam uniformly loaded, the safe load is  $W = \frac{8Ss}{12L}$ .

Therefore, it follows that  $\frac{8Ss}{12L} = \frac{1000wd}{L}$  or  $8Ss = 12,000wd$ , from which, letting  $s = 16,000$ , it is found that  $S = 0.1067wd$ . In other words, the section modulus is equal to the product of the weight of the beam per foot, the depth in inches and a constant 0.1067. That this is approximately true may be ascertained by comparison with any steel manufacturer's catalog.

There were cases in which the writer did not know the weight per foot of the beam in question and so could not apply the rule. So he made up a table, as follows:

Depth of Beam, In.	Value of Constant	Depth of Beam, In.	Value of Constant
3	16,500	10	250,000
4	20,000	12	278,000
5	28,750	15	330,000
6	33,500	18	390,000
7	40,500	20	430,000
8	44,000	24	490,000
9	48,000		

To use the table in applying the rule, divide the constant opposite the depth of beam by twice the span in feet. The result is the safe load hung in the center of the span. For channels the safe load is half that for an I-beam of the same size. The safe loads found by the foregoing constants will differ by only 5 or 6 per cent. from the actual safe loads.—*Power*, Sept. 24.

## Collective and Preferential Flotation

A Description Having Special Reference to the Bradford Process—Factors Involved in Flotation Processes—Preferential Wetting of Sulphides by Sulphur Dioxide—Use of Mechanical Beaters—Laboratory Control of Process

BY GUY C. RIDDELL

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**F**LOTATION is at the moment a much discussed branch of metallurgy. Indiscriminate or collective flotation, viz., the concentration of sulphides irrespective of kind into one mixed product, is generally employed the world over. Preferential flotation, viz., the separation of one class of sulphides from another into independent products, has attracted much attention of late, but is not yet generally applied in practice. This selective flotation is widely used in Australia, but there are a few instances only in which differential flotation is practiced successfully in the United States.

Though the principle of flotation dates back a number of years, it was not until sixteen years ago (1902) that active steps were taken in Broken Hill, Australia, to make practical use of the flotation property naturally possessed by mineral sulphides. Once demonstrated as a practical concentrating method, however, mine managers were quick to grasp the advantages offered by this method of treatment, and as a result various processes for the recovery of sulphides by flotation were speedily developed and used. It is curious to note that despite the great advantages of flotation, even the best of these processes are in some places still looked upon as a necessary evil. One frequently hears it referred to as a very simple but elusive method of treatment. This is undoubtedly due in many instances to a lack of appreciation of the value of testing and laboratory control.

Flotation calls for rather more special experience and skill in practical operation than do most metallurgical processes. Certain conditions peculiar to and varying with each particular ore have to be more or less rigidly maintained in the application of every form of the process. While it is true that most good metallurgy starts in the laboratory, in flotation particularly it is an axiom that the most suitable operating conditions should first be worked out in the research laboratory and subsequently passed on to the operating department. Many mistakes are made that result in the loss of values in wholesale fashion by making alterations in the running plant without knowing in advance the effect of such alterations.

### THE FACTORS INVOLVED IN FLOTATION PROCESSES

Generally speaking, there exists a more or less critical balance between the various essentials in all flotation processes. The nature and degree of crushing, the proportion of coarse and fine in the crushed ore, the density of the pulp, temperature and quantity of acid additions, the degree of agitation and (or) aëration, the kind and quality of oil or emulsifying agent used and the rate of settling of the pulp are the principal factors which require careful study. A

complete series of laboratory tests should be made to ascertain the effect of varying one or more of these factors in the case of each independent ore. Unless the sulphides are very easily floatable slight changes in the balance of any of the above conditions will often upset recoveries substantially. Fortunately the margin of latitude in the critical variables is sufficiently great in the case of most ores to leave the treatment thoroughly practical. At the same time the conditions cannot be too freely tampered with if good results are to be maintained.

It has been in a large measure due to this special requirement on the part of flotation processes that they are not applied except where ordinary gravity concentration fails to accomplish results. It also explains why flotation is looked upon with suspicion by the mill man. One finds very few instances where flotation is employed, as it should be, to replace inefficient work done by gravity methods of concentration. In other words, flotation is often tacked on only as an appendage to gravity concentration. This fact explains why some plants are only at the flotation introduction stage today, when they ought to have been reaping a rich harvest a decade ago.

### WETTED AND NON-WETTED SULPHIDES

Just as collective flotation methods have been in the past arrested in their development, so also are preferential flotation methods now running the gantlet. And since these latter methods demand a still more careful control as compared with collective flotation, one may suppose that they will take longer to come into their own. And yet it is possible that this may not be so, by reason of the fact that there exist many deposits of complex ores which are not amenable to the ordinary methods of treatment. These "diseased" ores have so far remained a locked up potential asset; with the advent of successful preferential methods of treatment they will be resolved into valuable products.

Any preferential process destined to full success must have as its basis some positive means of wetting one or more of the mineral sulphide particles, while leaving another temporarily immune to wetting. After such a treatment the non-wetted class of sulphides can then be floated by themselves, leaving the wetted sulphides submerged. Moreover, it is necessary in such a process that the wetting of the particular sulphide must be of such a nature that its air film can be restored when required, so that after the complete removal of the non-wetted class of sulphides the wetted sulphide can subsequently also be floated from the gangue.

Leslie Bradford, one of Australia's leading metal-



lurgists, has discovered such a positive direct preferential method of flotation, in the  $\text{SO}_2$  process patented by him in Australia four years ago, which has been in practical operation for the past three years in Broken Hill. The process is a very simple one and it seems destined to come into prominence, as it offers a means for the separation of lead, copper and pyrite, together with the silver and gold, from the blende—the solution of a vexing problem at many a refractory ore deposit.

#### PULP ACIDIFIED WITH SULPHUR DIOXIDE

The preferential effect in this operation is obtained by the addition to the pulp of either hyposulphite of soda and sulphuric acid, or sulphur dioxide gas. The  $\text{SO}_2$  gas is produced from burning sulphur and is allowed to bubble into a small storage box at the head of the plant. In some cases  $\text{SO}_2$  gas produced from roasting operations answers. In addition to adding the sulphur dioxide at this head box it is sometimes necessary to provide pipes for the admission of the gas into the agitators connected with the flotation vessel. It is found that under these conditions the galena and pyrite float by themselves and that the blende is wetted and refuses to float.

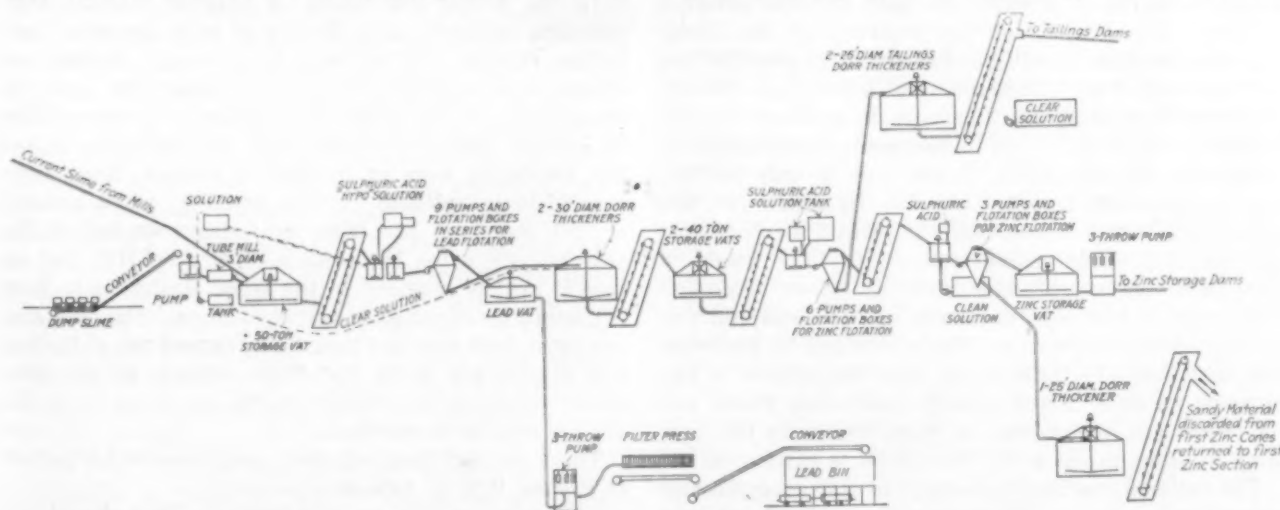
This preferential action is explained as follows: It can be said briefly that all flotation of sulphide ores is dependent on the presence about the particle of a gaseous envelope. Mr. Bradford solved the problem of removing the gaseous envelope from some sulphides without removing it from others. Theory suggested and experience proved that such a result could be accomplished by the action of a suitable reducing agent contained in

The fact that the blende particles are not changed chemically is of great practical importance, since those particles are not rendered permanently incapable of flotation, but only temporarily immune thereto. So long as they lie in this reducing solution they will remain wetted, but as soon as transferred from that solution and aerated (or the solution oxidized and aerated) they immediately regain their gaseous envelope and exhibit the same flotation phenomena as at first.

Having removed the galena completely, the blende is floated by itself from the gangue by either dissipating the small quantity of  $\text{SO}_2$  gas by steam or by transferring the deleaded pulp to a separate set of flotation boxes after the removal of the bulk of the sulphurous liquor, which is returned to the deleading section. These methods are equally successful.

The Junction North Silver Mining Co., Broken Hill, employs the former method. This company introduced the  $\text{SO}_2$  preferential process some three years ago and is quite satisfied with results. It has been in continuous operation at this mine since its introduction. It is here being used in a minerals separation impeller type of apparatus, the emulsifying agent being eucalyptus oil. About 2500 tons weekly are going through this plant.

The accompanying flow sheet shows the slimes plant in which the process is being used at the Broken Hill Proprietary Co.'s mine in Australia. This is self-explanatory. A notable feature is that no oil or other organic emulsifying agent whatsoever is employed in this plant. For some time sodium sulphate or nitre cake (from five to seven lb. per ton of slime) was added to promote emulsification of the pulp, but this is found



FLOW SHEET OF SLIME PLANT

the floating medium, this agent being one which removes the gaseous envelope without chemically changing the ore. Tests and experiments proved that sulphur dioxide gas dissolved in the liquid reduces and removes the gaseous envelope from the blende particles, without affecting the film which surrounds the pyrite or galena particles; wherefore the subsequent flotation treatment (which may conveniently be, and preferably is, performed simultaneously in the same liquid) removes the pyrite and galena (the non-wetted particles), while the sulphide of zinc (which is wetted, owing to the solution and removal of its protecting gaseous envelope) falls to the bottom along with the gangue.

not to be necessary and is no longer used. No hyposulphite of soda is now added to the pulp, sulphur dioxide gas alone being employed. The quantity of  $\text{SO}_2$  used is equivalent to  $1\frac{1}{2}$  lb. sulphur per ton slimes treated. Excellent results are being obtained from this plant, which is handling some 3000 tons per week.

#### THE USE OF MECHANICAL BEATERS

Broken Hill flotation practice in general has a distinct leaning toward the more intensive agitation methods and apparatus. There was a period at Broken Hill when it was thought that mechanical aëration (beating of air into pulp by churning) was not a necessity, but all

companies have eventually gone over to mechanical agitation of a very positive order. At the B. H. P. mill, in fact, an enclosed centrifugal pump agitator is in use—patented by Leslie Bradford in 1911—which agitates and churns the pulp under pressure. The resulting aëration and gasification is intensive and thorough, and the subsequent separation of metallic sulphides in the spitzkasten into which the centrifugal pump delivers is accomplished entirely without the use of oil in the flotation medium.

Now that SO<sub>2</sub> preferential flotation has passed through the experimental stages and definitely taken its place among the approved processes, further extension of its application is at hand. Up to the present time the treatment has been limited to slimes, but since it effects a preferential flotation in acidulated solutions and is not upset by additions of varying quantities of oils or other frothing agents, it follows that coarse sand of floatable size can be as efficiently treated as the slimes. This is an important feature, and one that is destined to increase the scope of flotation considerably.

#### FLOTATION SHOULD NOT BE A MERE GRAVITY PROCESS FINISHER

Heretofore the treatment adopted generally in Australia has been to subject the slimes resulting from gravity concentration to preferential flotation methods in a separate flotation unit. The Broken Hill ores at center of lode carry a heavy rhodonite content, and the blende is not readily separable by gravity methods. Crude ores run 15 to 16 per cent Pb, 13 to 16 per cent Zn and 12 to 13 oz. Ag. The pulp is de-leaded to the ultimate degree by gravity methods and the de-leaded material then floated for the recovery of the blende from the gangue. I will not say that this practice is a poor one, but it is, in the opinion of some of the Broken Hill metallurgists themselves, open to criticism for the following reasons: (1) It necessitates a costly plant installation; (2) de-leading of fine grit is only partial; (3) flotation concentrates are low in grade for this reason and have to be tailed; (4) stratification of float concentrates yields indifferent results; (5) grade of zinc concentrates obtained after all these successive treatments is low; (6) recoveries of both lead and zinc are considerably lower than those obtained by preferential flotation; (7) flotation of sand and slimes in two separate flotation units requires additional plant, and recoveries are not as good as when admixed; (8) handling of slime products by themselves is expensive.

The rational treatment would be to stop concentration by gravity methods on all material as soon as it has been crushed down and reduced to floatable size, and to send the whole of the mill flow from this point direct to the preferential flotation plant. The presence of the slimes would assist the flotation of the coarser mineral, and the sand would assist the rate of settling of the slimes. The concentrates resulting from preferential flotation would call for no special means of handling. Recoveries obtained by this method of treatment would be much better, and costs would be lower. The grade of both lead and zinc concentrates would be considerably enhanced.

In fact, if an ore has to be crushed down to floatable size before concentration becomes possible, there is no reason why gravity concentration in such a case should

not be entirely dispensed with to advantage. Experiments and tests made by the Bradford process on crude ores have yielded excellent results. Mill flows after the coarse Wilfley tables, i.e. both sand and slime together, have also been tested and have been found in all cases to yield excellent recoveries and high-grade products.

The SO<sub>2</sub> process differs from other preferential processes in that it offers a positive means of wetting the blende. It is much more elastic than other preferential processes, and, unlike these, which are only applicable to the treatment of slimes or impalpably fine mill products, it can successfully float comparatively coarse galena particles.

Experimental tests have been made on several hundred tons of pyrite-galena-zinc ores outside the Australian field, representing the complex ores of Tasmania, India, Canada, Mexico and the United States, and in every instance the SO<sub>2</sub> treatment in the hands of an operator experienced in the process has effected an excellent separation of the lead, copper and pyrite from the blende. The ores on which the process has been tested are notably those belonging to that class of intimately mixed and difficultly separable ores known as "diseased." The complex sulphide ores of the Rosebery-Hercules mines in Tasmania containing blende, galena and pyrite gave a zinc concentrate containing up to 58 per cent Zn, with recoveries from 80 to 85 per cent.

#### THE FEATURES OF A PROPER LABORATORY CONTROL

The laboratory testing of ores by the SO<sub>2</sub> treatment requires a considerable amount of skill and patience until the proper regulation of sulphur dioxide, temperature, sulphuric acid, density of pulp, degree of agitation, rate of settling, etc., is attained. Several instances are recorded where preliminary and even repeated tests in the hands of operators who were skilled in general flotation methods but inexperienced in the SO<sub>2</sub> treatment were of indifferent success, these same ores yielding splendid results, however, when handled by SO<sub>2</sub> men. It has been fully demonstrated in the several mills using the process at Broken Hill that no special skill is required in the large size plant to keep SO<sub>2</sub> additions adjusted to suit conditions. The bulk concentrates, both zinc and lead, being turned out at Broken Hill remove any doubt that these remarks on the laboratory testing of the process might convey as to its being too neat to be practical.

There are certain points that receive careful attention at Broken Hill, as follows:

1. Density of pulp on lead section. This should not exceed 27 per cent solid by weight. Higher pulps do not yield maximum grade of lead concentrate, and the zinc concentrate in turn suffers.

2. Temperature of pulp at head of lead section. This is kept below 90 deg. F. At temperatures above this the zinc shows tendency to float.

3. Acidity of pulp on lead section. This is not allowed to go much above 0.03 per cent. Higher acidity than this acts much as does too much temperature. If the solution, however, becomes neutral, lead concentrate falls off in grade because of gangue passing over with it. Both temperature and acidity are readily controlled in practice, and results are uniform and regular.

4. SO<sub>2</sub> pipes must not become choked. The lead con-



concentrates remain clean only as long as the  $\text{SO}_2$  feed is properly delivered, and a choked pipe promptly shows itself in the color of the lead flowing from the spitzkasten. The cause of this trouble is volatilized sulphur due to excessive heat in the sulphur-burners which supply the  $\text{SO}_2$ . It is checked by having a few holes in the 3-inch  $\text{SO}_2$  main which can be opened when the temperature of the burner rises unduly, the air entering through these checking the draft and combustion at the burner.

$\text{SO}_2$  selective flotation on Broken Hill ore is producing and maintaining a notably high grade of zinc concentrates (viz., 50 per cent), with lead concentrates averaging 63 per cent. It is the only preferential process so far made known which operates in the presence of acid. This is a great advantage in that coarser size lead particles can be recovered by preferential flotation without trouble.

The Bradford process is now being worked on three companies at Broken Hill, the aggregate tonnage being put through amounting to approximately 8000 tons weekly. Its extensive adoption in Australia has come about after a number of years of more or less successful trials with various other preferential treatments that have had a vogue at Broken Hill but which have lacked the positive dependable action of the  $\text{SO}_2$  method.

## Application of Zinc in the Building Trades

BY J. A. SINGMASTER

A GREAT many persons associate the word "zinc" with a cast rod commonly used in electrical batteries. This product is brittle and crystalline and can be readily broken. They do not know that zinc is rolled and that in this shape it is remarkably ductile and tough. It is extremely resistant to atmospheric corrosion and in view of these qualities has found a tremendous application in the building trades in Europe. It displaces the more expensive metals, such as copper and lead, for roofing, flashing, spouting and guttering, with no sacrifice of durability and at considerable saving in first cost. Tin andterne-plate and galvanized iron, which we so commonly use for exterior work, are usually cheaper in first cost, but when length of life, cost of painting and replacement are taken into account they are more expensive for permanent construction.

Rolled zinc is now largely used in this country in the manufacture of so-called "leaded" glass, where rolled zinc sections of any desired shape support the glass. This zinc often is given the lead finish desired for architectural effect, and is much stiffer and more durable than the metal it has replaced. It is also made in the shape of shingles or tile, which can be treated to give most artistic effects, possessing the great advantage of permanence and unbreakability. Spouting and guttering of zinc have artistic possibilities, and in addition the owner will not be able to poke his finger through the leaders on his house at the end of three or four years, nor will he have to paint them continually.

Rolled zinc is also used largely in this country for weather-strips where permanency and ultimate cost are a consideration. It has, of course, been used for years

in fastening glass in wooden frames in the shape of the familiar glaziers' "points."

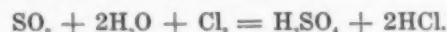
The use of zinc demands a certain familiarity with the metal, which can be had with a little practice, and the selection of the proper quality of material for any given application. Zinc can be hard, medium hard and soft rolled. Hard rolled zinc would not stand bending for seam work, while soft metal can be drawn, bent and spun into the greatest variety of shapes. One of the great drawbacks to its use in the past has been the lack of appreciation of this point. No one using brass sheet would think of ordering it without specifying the kind of brass, yet ordinary zinc sheet is expected, when bought from a dealer, to meet any and every use, without due consideration of its physical properties.

A popular misapprehension exists regarding the soldering of zinc, numerous statements having appeared regarding the solution of this supposedly difficult problem. On the contrary, zinc is one of the easiest soldered metals. Any one desiring to inspect a soldered joint can do so by removing the paper or cardboard cover from an ordinary dry battery cell, such as is used for operating doorbells, all dry battery cells being contained in soldered zinc cans.

A large expansion in the use of zinc in the building trades is certain to come here as it has come in Europe. Those who first take advantage of this development and familiarize themselves with the possibilities and uses of zinc will reap the benefits which have repeatedly come to those in every branch of industry who have studied and applied foreign improvements to American practice.

New Jersey Zinc Co.,  
New York, N. Y.

**Detinning Scrap.**—O. K. ZWINGENBERGER of Tompkinsville, N. Y., notes that in the process of detinning scrap small traces of water left on the metal or in the chlorine gas are very detrimental to the yield of tin tetrachloride. It is very difficult to remove the last traces of moisture in the reacting substances. Its presence causes the formation of crystalline tin tetrachloride which covers the metal like snow, absorbs liquid  $\text{SnCl}_4$ , and prevents the effective penetration of chlorine gas to unaffected surfaces. Thus it reduces the recovery of tin, and at the same time wastes chlorine, especially as water vapor induces the formation of iron chlorides. The inventor absorbs these traces of water by adding 5 per cent of the quantitative amount of sulphur dioxide according to the following reaction:



As  $\text{H}_2\text{SO}_4$  of greater concentration than 66 deg. B. does not dissolve iron and dry  $\text{HCl}$  is also inactive, the formation of stannic chloride is not hindered. The sulphur dioxide and the chlorine are mixed in a mixing chamber or tower at such a rate that the above reaction shall be completed some time before the recovery of the tin is completed. The rate of  $\text{SO}_2$  admission is also greater at first in order to take care of the water contained in the dried scrap. The reaction takes place in the detinning pot to a large degree and does not interfere with the formation of tin chloride, in fact by the removal of water vapor it prevents the retention of crystalline tin compounds in the treated mass. (1,260,119; Mar. 19, 1918.)

## Fusibility of Coal Ash From West Virginia Coals\*

The Method of Preparing Ash for Fusion Tests and Determining Initial Softening Temperature and Interval of Fusion—A Summary of Tests on West Virginia Coals, Including the Monongahela, Conemaugh, Allegheny and Pottsville Series

By WALTER A. SELVIG

INFORMATION concerning the fusibility of coal ash has become of considerable interest to the consumer of coal during the last few years, principally in connection with the troublesome formation of clinker which results from the melting of the ash constituents of the coal when subjected to heat.

The growing interest for such data has led the Bureau of Mines to make a general survey of the "fusing" or "softening" temperatures of the ash from well known American coals. It is hoped that this information when used together with the large number of coal analyses made available by the publications of the Bureau of Mines<sup>1</sup> will be of help to the consumer of coal in comparing the different coals and in the selection of the coal best adapted for his purpose.

This paper gives the results obtained for West Virginia coals, among which are found some of the purest fuels of the country.

The method employed for the fusibility tests was the standard gas furnace method<sup>2</sup> of the bureau. In order better to interpret the results given in the table of fusibility this method is briefly summarized here.

### PREPARATION OF CONES

The coal samples are ground to 60 mesh, with crusher, rolls and ball mill. This 60-mesh material is then placed in shallow fire-clay roasting dishes and completely ashed in a muffle furnace at a temperature of 800 deg. C. to 900 deg. C.

The resulting ash is ground in an agate mortar to pass a 200-mesh sieve. To make sure that the coal has been completely ashed, the ash after grinding is placed in fused silica capsules and ignited at 800 deg. C. for two hours, a current of oxygen gas passing through the furnace during the ignition period. This ignition is made to insure complete and uniform oxidation of the ash.

A portion of the ash is transferred to an agate mortar, moistened with a 10 per cent dextrin solution and worked into a plastic mass with a spatula. The ash is then molded into solid triangular pyramids  $\frac{3}{4}$  inch high and  $\frac{1}{4}$  inch wide at the side of the base. These cones are removed from the brass cone mold, dried and mounted in a vertical position in a refractory

base made up of a mixture of two parts of kaolin to one part of calcined alumina. Usually five cones are mounted in the same base. The base with the cones is dried carefully over the hot plate until all water is driven off, then the dextrin is burned out of the cones by igniting the mounted cones in a muffle furnace at a dull red heat, after which the cones are ready for use.

### DESCRIPTION AND OPERATION OF FURNACE

The furnace used was the No. 3 melter's furnace (Fig. 1) of the American Gas Furnace Co., natural gas and air pressure of from 2 to 3 pounds to the square inch being used. The cones, supported by a suitable mounting, are placed within a covered fire-clay crucible in the furnace. A 2-in. hole is drilled through the furnace jacket and fire-clay crucible for observation purposes, a fused silica tube carrying a thin glass window being placed in the observation hole. At right angles to the observation hole a  $\frac{1}{4}$ -in. hole is drilled through the furnace and crucible. Through this hole a platinum-rhodium thermo-couple, protected by a glazed porcelain tube, is inserted. By proper adjustment of the gas and air a reducing atmosphere is maintained within the furnace, this being accomplished by using the minimum amount of air necessary to attain the desired temperature. Under these conditions, the iron in the ash is



FIG. 1. NO. 3 MELTER'S FURNACE AND ACCESSORIES

reduced to the ferrous state, which condition gives the lowest melting points and therefore gives the lowest temperature at which clinkering may result. The temperature is gradually increased to 800 deg. C., when the rate is slowed down to not less than 5 deg. C. nor more

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<sup>1</sup>Lord, N. W., and others: Analyses of coals in the United States, with descriptions of mine and field samples collected between July 1, 1904, and June 30, 1910: Bull. 22, Bureau of Mines, 1913, 1200 pp. (In two parts.)

<sup>2</sup>Fieldner, A. C., and others: Analyses of mine and car samples collected in the fiscal years 1911 to 1913: Bull. 85, Bureau of Mines, 1914, 444 pp.

Fieldner, A. C., and others: Analyses of mine and car samples collected in the fiscal years 1913 to 1916: Bull. 123, Bureau of Mines, 1917, 456 pp.

<sup>3</sup>For detailed description of this method and discussion of the influence of various factors on the fusibility of coal ash see Fieldner, A. C.; Hall, A. E., and Feld, A. L.: The fusibility of coal ash: Bull. 129, Bureau of Mines, 1918, 146 pp. (In press.)



than 10 deg. C. per minute, this rate being maintained until the end of the test, when a maximum temperature of 1500 deg. C., or 2732 deg. F., is attained.

In some instances with coal ash of an especially refractory nature the cones which did not fuse at the highest temperature attained in the gas furnace, were further heated in a molybdenum wire resistance furnace<sup>1</sup> in an atmosphere of hydrogen gas. Under these conditions temperatures as high as 3010 deg. F. and in some instances slightly higher were attained. However, a coal whose ash fuses above 2730 deg. F. should give very little trouble due to clinker formation.

The temperature readings taken were:

(1) *The initial deformation temperature.* The temperature at which the first rounding or bending of the apex of the cone takes place as shown in cone 1 of Fig. 2.

(2) *The softening temperature.* The temperature at which the cone has fused down to a spherical lump as shown in cones 2 and 3 of Fig. 2.

Only the average softening temperature is reported, together with the softening interval, which is the difference in degrees between the softening temperature and the initial deformation temperature.

#### INTERPRETATION OF FUSIBILITY TABLE

According to the West Virginia Geological Survey there are 102 known coal beds in West Virginia, of which 52 are minable. The table contains samples representing nearly one-half of these minable beds, the beds listed being among the most important in the state.

The various beds are arranged according to their geological succession, from information supplied by courtesy of the West Virginia Geological Survey together with information taken from the Keystone Coal Catalog,<sup>2</sup> the uppermost coal beds being listed first. The succession of coal beds, with the average softening temperatures, softening interval, ash per cent and sulphur content, is as follows:

	Average Softening-Temperature, Deg.	Softening Interval, Deg.	Ash, Per Cent.	Sulphur, Per Cent.
<b>Monongahela Series:</b>				
Sewickley Bed.....	2080	80	9.61	3.99
Redstone Bed.....	2120	150	6.96	1.92
Pittsburgh Bed.....	2170	90	7.20	2.24
<b>Conemaugh Series:</b>				
Mahoning Bed.....	2160	130	5.62	1.89
<b>Allegheny Series:</b>				
Upper Freeport Bed.....	2190	220	6.17	1.97
Lower Freeport Bed.....	2090	110	9.84	3.14
Middle Kittanning Bed.....	2110	110	10.93	4.06
Lower Kittanning Bed.....	2660	140	7.64	1.76
<b>Pottsville Series:</b>				
<b>Kanawha Group:</b>				
Coalburg (Buffalo Creek).....	2960	80	8.80	0.76
Winifredo (Black Band).....	2970	170	8.44	0.83
Cedar Grove (Thecker).....	2610	160	5.83	1.07
No. 2 Gas (Campbell Creek, Island Creek, Upper War Eagle).....	2750	120	5.86	0.88
Eagle.....	2940	150	4.40	0.77
<b>New River Group:</b>				
Sewell (Davy).....	2560	160	3.93	0.72
Welch (Tug River).....	2840	180	7.41	0.62
Beckley (War Creek).....	2800	150	4.76	0.65
Fire Creek (Quinnimont).....	2540	130	6.60	0.84
<b>Pocahontas Group:</b>				
Pocahontas No. 6.....	2400	120	2.88	0.70
Pocahontas No. 5.....	2700	100	6.23	0.62
Pocahontas No. 4.....	2480	110	6.31	0.64
Pocahontas No. 3.....	2440	140	4.70	0.59

It will be noted that the uppermost series given is the Monongahela series, there being no samples represent-

ing the overlying Dunkard series, which top out the highest beds in the Appalachian field; however, these coals are of very little commercial importance at the present time.

The results for each mine show the lowest softening temperature, the highest softening temperature and the average for the mine. The softening interval is tabulated in the same manner. In addition to these values the per cent ash and sulphur, on the dry coal basis, is given.

#### DISCUSSION OF RESULTS

The average values given for each bed provide a means of comparison of the different coals; however, of course, the average values are averages of the mines which are listed under each bed, consequently the

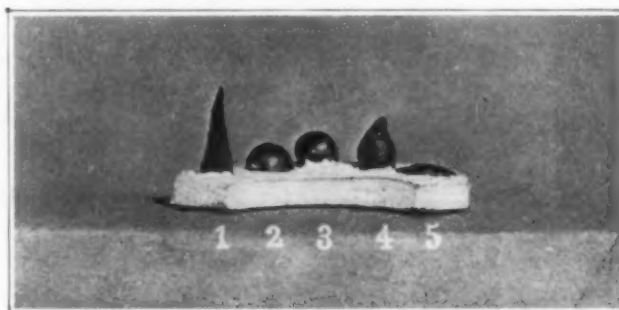


FIG. 2. TYPICAL FORMS OF CONES FUSED IN THE NO. 3 MELTER'S FURNACE

greater the number of mines sampled the more representative the values are of the bed. In some instances only a few mines are listed under the bed. In these cases the average values given are only representative of the mines sampled, and do not constitute a fair average of the bed. Beds such as the Pittsburgh, Sewell, Beckley and Pocahontas No. 3, from which a large number of samples have been tested and the softening temperature values for the various mines are uniform, the average values given may be taken as representative of the bed.

It will be noted that the softening interval values given in the table vary to a considerable extent. These values, as already explained, give the number of degrees interval between the temperature at which the tip of the cone fuses or bends and the temperature at which the cone has fused down to a spherical lump, which temperature is recorded as the softening temperature. The point at which the tip first fuses or bends is rather difficult to obtain exactly on account of the phenomena of warping and shrinking of the cones which sometimes result when the cones are subjected to heat. The softening interval is interesting mainly as a study of the viscosity of the melting ash. The softening temperature values given are the values which are used in comparing the different coals. This is the most definite and easiest point to check in the tests.

#### DISCUSSION OF COAL BEDS TESTED

Under the Monongahela series the Sewickley, Redstone and Pittsburgh beds are listed. Not sufficient mines are represented to give representative average values for the Sewickley and Redstone beds. The Pittsburgh bed, which is the most important coal bed in the

<sup>1</sup>Fieldner, A. C., and Feld, A. L.: "A New Method and Furnace for the Determination of the Softening Temperature of Coal Ash Under Fuel-Bed Conditions," *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 10, 1915, pp. 829-835.

<sup>2</sup>"The Coal Catalog, Combined with Coal Field Directory," for the year 1918, Keystone Consolidated Publishing Co., Pittsburgh, Pa., pp. 579-588.

northern part of West Virginia and contains one of the most valuable fuels of the country, is fairly well represented. This bed varies considerably as to sulphur content in different regions. It will be noted, however, that the softening temperatures as given are fairly uniform, but are lower than many of the other beds listed.

The mines listed under the Conemaugh series are all coal banks from the Mahoning bed, which is of no commercial value but is mined for local use. The average softening temperature from these coal banks is practically the same as that of the Pittsburgh bed.

In the Allegheny series the lower Kittanning or No. 5 Block bed is a very important coal. This bed varies from a high volatile coal in the southwestern half of the state through an ordinary bituminous type of coal in Randolph and Barbour counties to a semi-bituminous coal in the North Potomac basin.<sup>5</sup> As might be expected from a coal varying so much in composition, the values given for this bed vary over a wide range, but no doubt the mines listed give representative values for their immediate districts.

The coals listed under the Kanawha group of the Pottsville series are coals giving ash having a uniformly high fusing temperature. The No. 2 Gas is the most important and valuable bed of this group and is widely known commercially. This bed as well as others of this group contains coals giving ash having a high fusing temperature.

The New River group of the Pottsville series contains some of the best known coals of the country, coals having a low ash and sulphur content, also giving an ash with a high fusing temperature.

The Sewell bed, which is the most important of the New River group, is very well represented in the table. The mines tested give a very uniform fusibility of ash value, and the average value for the bed is good. This coal, which is semi-bituminous in character, is one of the famous steam-producing coals of the country and is the most extensively developed of the New River coals.

The Beckley bed, which is a very important member of the semi-bituminous coals of the New River group, shows some remarkably high fusibility values. The ash from this coal is of a specially refractory nature and this bed gives fusibility values higher than any other of the beds of West Virginia that were tested. This coal should prove of interest to consumers demanding a high grade coal giving an ash of an exceptionally high fusibility.

The last group listed and the oldest and lowermost of the West Virginia coals is the Pocahontas group, which contains the famous Pocahontas No. 3 bed of Mercer and McDowell counties. This seam produces the well known Pocahontas semi-bituminous coal, which is one of the purest coals of the country and is being used extensively as a steaming and coking coal. The average values given for this bed represent 246 samples, so should be very representative of this celebrated coal. As is seen, the figures representing the different mines are very uniform. Although the average softening temperature of this bed is not as high as some of the others, especially the Beckley bed, it is uniformly high and little trouble should be experienced from clinkering.

<sup>5</sup>(a) West Virginia Geological Survey, Bull. II, "Levels and Coal Analyses," 1911, p. 296.

Grateful acknowledgment is made to A. C. Fieldner, chemist, formerly of the Pittsburgh Station of the Bureau of Mines, under whose supervision most of the tests were made. Many of the tests were made by Messrs. A. E. Hall, V. C. Allison, C. R. Locke, C. S. Purcell, W. C. Ratliff and O. C. Brown, all of the chemical laboratory of the Bureau of Mines.

Chemical Laboratory, U. S. Bureau of Mines,  
Pittsburgh, Pa.

## The War and the Nitrogen Industry\*

By W. S. LANDIS

JUST sixteen years ago the writer had the good fortune to see in operation at Niagara Falls the first large scale unit for the fixation of atmospheric nitrogen. This costly experiment of Bradley and Lovejoy did not prove the commercial success anticipated, but in its two years of operation it served to attract the attention of the world to the nitrate phase of the industry. The principles so well demonstrated at Niagara, when carried to Europe with its more favorable natural advantages and economic conditions, started a development that has commercially survived to the present time. Had Bradley and Lovejoy enjoyed the advantages of Norway, we might today find their names as prominent in the industry as Pauling and Schönherr, if not Birke-land and Eyde.

### THREE TYPES OF NITROGEN FIXATION PROCESSES

The fixation of nitrogen has developed along three divergent lines with many secondary outgrowths. The oldest process dated back to Cavendish, who in 1785 undoubtedly produced some nitric acid by passing the electric spark through air. Bradley and Lovejoy in 1901 attempted to do the same thing on a commercial scale and had their apparatus in operation in 1902. Just about the time the Niagara work was abandoned Birke-land began his experiments in Norway, using a somewhat different style furnace. Schönherr followed with his furnace, and still later Pauling. The product of all of these processes was nitric acid or derivatives of the same. Many others have since entered the field, but have made little progress in a commercial way.

A second school, and I am including here only those processes which have survived in one form or another, is that which concerned itself with the fixation of atmospheric nitrogen in the form of cyanides and cyanamides. Frank and Caro for many years attempted to produce cyanide through the direct fixation of atmospheric nitrogen. Commercially unsuccessful in this attempt, they, however, succeeded in a small way in producing cyanamide from atmospheric nitrogen and calcium carbide about 1900, or just prior to the nitric acid work of Bradley and Lovejoy. They did not, however, make much progress in the development of their process in the early days, and it was not until 1906 that a commercial installation followed. Later followed the conversion of cyanamide to ammonia, and quite recently the oxidation of this ammonia to nitric acid.

The third school following the production of ammonia synthetically, from its elements, nitrogen and hydrogen, is represented in the work of Haber and

\*A paper read before the American Electrochemical Society on Oct. 1, 1918.



carried out almost simultaneously with Birkeland's developments in Norway.

These three systems of fixation which have survived to the present time are none of them twenty years old and in fact essentially had no producing capacity even twelve years ago. Ten years will actually cover the commercial history of the industry.

#### THE STATISTICS OF NITROGEN PRODUCTION

Before the advent of the fixation processes, the world's requirements of nitrogen were met by the nitrate beds of Chile, the recovery of ammonia in the coking of coal and the production of illuminating gas and from various vegetable meals and animal by-products. We are going to consider only the chemical nitrogen product in our further discussion. According to the best available statistics, ten years ago, or in 1908, the world's production of nitrogen in the form of Chilean nitrate and of sulphate of ammonia was equivalent to only 503,000 short tons of nitrogen. The fertilizer industry was the larger consumer of this nitrogen, and since the capacity of the cultivated acreage of the world for absorption of this nitrogen was fifty or one hundred times the above production, there was ample incentive for the development of an air fixation process.

In 1914, at the outbreak of the European war, the producing rate of the world in short tons of chemical nitrogen, according to the best available statistics, is given in the following table:

Material:	Nitrogen, Short Tons
Nitrate of soda.....	425,000
Sulphate of ammonia.....	285,000
Arc process products.....	11,000
Cyanamide products.....	31,000
Synthetic ammonia and miscellaneous.....	12,000
Total—short tons nitrogen.....	764,000

In 1919, say five years later, the producing capacity of the world, including the United States Government nitrate plants now under construction, is estimated to be as follows:

Material:	Nitrogen, Short Tons
Nitrate of soda.....	520,000
Sulphate of ammonia.....	330,000
Arc process products.....	15,000
Cyanamide products.....	360,000
Synthetic ammonia and miscellaneous.....	116,000
Total—short tons nitrogen.....	1,341,000

#### UNIFORM INCREASE IN PRODUCTION

An analysis of the production statistics of the world for ten years prior to the outbreak of the war shows a very uniform rate of increase. The curve is almost exactly a straight line. If we carry this rate of increase forward into the future it indicates a producing rate for 1919 of 1,330,000 short tons of nitrogen, or essentially the same as our figure given above for actual production, 1,341,000 tons. Such a system of analysis, it seems, is justified in view of the very uniform rate of increase noted for years prior to the war, and we are forced to the single conclusion that as relates to the world as a whole there has not been the great over-expansion of producing capacity most of us have believed. The available nitrogen supply expanded under the influence of the war only to the point any one would have predicted in the spring of 1914 from a study of its past statistics.

In this connection it might be here added that about

1911 the world's production of nitrogen began to catch up with market demands as limited by the comparatively unexpanded trade channels which had not kept up with the increase of production. Prices slumped as a result, reaching the lowest point in the history of the industry in 1914, and only the outbreak of the war with its insistent demands saved a portion of the industry from financial disaster.

It is a question if a problem is confronting the world's nitrogen industry at the close of the war. Undoubtedly the demand will drop off somewhat with the advent of peace, but with the anticipated high food prices continuing for some time afterward, this drop in nitrogen consumption should not be excessive. On the other hand, many plants erected under the war-time emergency are so located geographically and economically that operation after the emergency is past will be impossible. We may, therefore, expect a material reduction in producing capacity. That the decrease in demand and in production will be somewhat of the same order is at least a plausible assumption, and we see no real reason for altering our earlier conclusion as to the existence of a real primary problem, as concerns supply and demand.

#### READJUSTMENT OF PRICES AND MARKETS IS BOUND TO COME

Of secondary interest, there is bound to be much readjustment of prices, markets, distribution, etc., for the new plants are located in many cases in consumption centers formerly drawing from a distance for their supplies. Former importers may become exporters and new products must supplant older varieties of materials. Legislation may even play an important part in affecting consumption not alone of the nitrogen, but even of the specific variety. The influence of these phases, secondary in a sense to supply and demand, cannot be foretold. A recurrence of the 1914 condition may ultimately occur again, particularly as there has been no expansion of propaganda and educational methods and sales organizations since 1914.

In the case of the United States the statistics, however, partake of a very difficult character. In 1914 the United States possessed no commercial fixation plants; the consumption was as follows:

#### U. S. CONSUMPTION OF NITROGEN IN 1914

Material:	Nitrogen, Short Tons
Nitrate of soda (import).....	94,300
Equivalent sulphate of ammonia (domestic).....	36,600
Equivalent sulphate of ammonia (import).....	17,800
Cyanamide products (import).....	5,400
Total—short tons nitrogen.....	154,100

#### UNITED STATES NITROGEN STATISTICS

It is extremely difficult to estimate for 1919 a similar consumption rate. I am, however, reproducing here some figures which are at least representative of the magnitude to which the industry has grown, having included the best information on anticipated outputs of coke ovens and on the new Government nitrate plants now under construction and which will be in operation very early in the spring:

#### ESTIMATED PRODUCTION RATE 1919, U. S.

Material:	Nitrogen, Short Tons
Nitrate of soda.....	300,000
Equivalent sulphate of ammonia.....	100,000
Cyanamide products (import).....	13,000
Cyanamide products (domestic).....	85,000
Synthetic ammonia.....	10,000
Total—short tons nitrogen.....	509,000

The producing rate in the early part of 1919 will, therefore, be approximately three times that at the outbreak of the war. Before the war half the chemical nitrogen entered into the fertilizer industry, which for a considerable period of time has shown an increase of only about 10 per cent from year to year. Assuming this increase, applied to the whole industry, would have continued for the duration of the war, it is hardly to be expected that the consuming capacity at the beginning of 1919 should exceed 225,000 tons of nitrogen per year had there been no war.

#### INDUSTRY FACES UNUSUAL PROBLEM

Judging from past history, our only guidance, we can expect at the close of the war a more or less disturbed state of affairs lasting over an indefinite time. We have no reason for assuming an enormously increased market for nitrogen to develop with peace, and in fact the chances are greatly in favor of a decline below the estimated 225,000 tons. With a production capacity of over 500,000 tons and a maximum consumption of less than half that tonnage, the industry in the States faces an unusual problem.

Importation of nitrate of soda makes up over half the available tonnage. Undoubtedly a material reduction of this import will follow peace, possibly sufficient to balance supplies and demands. There will always be some demand for nitrate of soda in agriculture and the oxidation of ammonia will make only slow headway in the already equipped and amortized chemical plants, so we cannot hope for a complete cessation of nitrate imports. Certain fixation plants erected as war emergency plants will undoubtedly close down with the declaration of peace, or at least suspend during a period of removal to more favorable peace market localities. Exportation of surplus production is not excluded from contemplation.

#### NITROGEN INDUSTRY MUST UNDERGO CHANGE

The nitrogen industry of the States must undergo a complete change, we must all admit. This enforced change, I believe, need not seriously affect the great producing interests of this country, but the distribution agencies are certain to be influenced. The changes of methods and materials will affect the consumer. Out of the whole can come much good.

For example, prior to the war, agriculture consumed about 50 per cent of the chemical nitrogen in the whole country in the form of mixed fertilizers. The ingredients, mostly low in content of plant food and collected from many places, were assembled at the seaboard and compounded there. This low plant food content, varying from 12 to 20 per cent of the whole, means high cost of assembling, mixing, bagging and transportation per unit of plant food. By the time the fertilizer had been transported 200 to 300 miles inland and distributed under an expensive system of credit the nitrogen cost the farmer about double its wholesale price at the ports. As a result 85 per cent of the fertilizer consumed in the country was used in a narrow strip of territory near the coast, and the enormous acreage of Middle Western cultivated lands went unfertilized. The high cost of the dilute fertilizer when transported to these states made its use either impossible or at least unattractive to the farmer from the standpoint of profitable return.

The great cereal crop-growing regions must have cheaper nitrogen to make available the vast market they present.

Now, neither the producer of the raw materials nor the compounder of the mixed fertilizer was a profiteer. A careful study of the situation—and statistics are available in ample quantity—shows that neither profited to more than a very moderate return on his invested capital. The difficulty lies in the enormous friction losses in handling a material averaging only between 12 and 20 per cent of valuable plant food and 80 to 88 per cent inert material. The labor, bags, freight and haulage applied to the inert material are lost. If they could be eliminated the cost of fertilizer could be reduced without either the producer of the raw materials or the compounder and distributor of the same suffering. With reduced cost to the farmer and more general distribution the cost of credits will be lowered. Half the price paid by the farmer went to the wholesaler of the raw materials and the other half for distribution. As this second half is largely proportional to the bulk handled, any means of reducing the inert material content should result in a lowering of these costs of mixing, bagging and distributing. The solution of the problem of a lowered cost of fertilizer is therefore logically one involving the production of a more concentrated material. And following the lowered cost will come the newer and larger markets with increased demand.

#### MUST FACE THE FACTS

The nitrogen industry of the United States, if it is to market its great production at the close of the war, must face these facts and be prepared to meet the issue. One of the youthful fixation processes has appreciated the situation and prepared itself through development of a concentrated fertilizer containing some 65 per cent plant food, more than four times as concentrated as an average mixed fertilizer. The cost of handling, mixing, bagging, freight and haulage will be cut in equal proportion to the concentration and it will be enabled to reach hitherto inaccessible markets, miles beyond the limit of the present dilute materials. The new fertilizer awaits only the close of the war and release of the ammonia supplies to enter the field. Crop tests have been carried out for some four to five years to show the value of nitrogen.

When fertilizer can be profitably put into the great Middle West the consumption will be enormous. Our apparently largely increased nitrogen production will not suffice to meet the demand. It would take the stimulating effect of several wars to build sufficient fixation plants to over-produce in such a market.

Thus the ten-year-old fixation industry with its freedom of action, absence of prejudice and broad appreciation of fundamental condition has not only come to the assistance of the Government in the war emergency, but has prepared itself to meet what might have been a serious national problem with the advent of peace. A closing of the plants with the world's shortage of food stocks is unthinkable, and yet such would appear on the face of statistics to have been the outcome had the problem not been attacked from its fundamentals. At least some of us do not look into the future with fear in spite of the figures.



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## Book Reviews

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**A MANUAL OF CHEMICAL NOMOGRAPHY.** By *Horace G. Deeming, Ph. D.* The University Press, Champaign, Illinois.

In this small pamphlet we have a most satisfactory practical treatment of the general method of graphical calculation, in its broadest sense, as applied to chemical problems of both scientific and industrial interest. That such methods in very many fields are of the greatest possible importance is not to be doubted; and the chemical profession owes a debt of gratitude to Dr. Deeming, not only for his general and excellent presentation of past work, but more especially for the new, original developments due entirely to him. This book, together with the accessories necessary for the practical application of the principles of the subject, which are now available, makes it possible for the first time for all chemists to employ this exceedingly useful method in their various calculations. And all chemists should consider it their duty to examine the book in order to see just what aid it can offer them in solving their problems, especially those which have more or less a routine nature.

**CHEMICAL COMBINATION AMONG METALS**, by Dr. *Michele Giua* and Dr. *Clara Giua-Lollini*. 341 pages. Price \$4.50 net. Philadelphia, P. Blackiston's Son & Co.

This book, which was awarded the prize of the Cagnola Foundation by the Royal Lombardy Institute of Science and Literature, has been rendered into very graceful English by Gilbert W. Robinson. It would be very noteworthy merely as a compilation presenting systematically the known binary equilibrium diagrams which give evidence of the occurrence of intermetallic compounds. Since the common conception of valency throws no light upon the formation of such entities, the authors make a main division of their subject into homopolar and heteropolar compounds, following Abegg. Thus, intermolecular forces are "polar" if they depend on the special affinity of the elements for electrons, while "unitary" forces lack this character. The valency of an element depends on the nature of the other elements with which it combines. Elements of distinct series in the Periodic System are heteropolar, while neighboring elements are homopolar. The greatest number of intermetallic compounds result from unitary forces and only in comparatively few cases are heteropolar compounds formed.

In another important chapter the authors outline what is known from systematic investigations of various physical properties of alloy series, such as conductivity, hardness, density and so on, pointing out that such studies are extremely important in reinforcing the evidence given by thermal analysis. Compounds are indicated by actual or submerged maxima on the liquidus; these compounds produce corresponding discontinuities or "singular points" on the curves representing a physical property plotted against composition.

The eminent Russian, Kurnakoff, has done much work in correlating thermal and electrical phenomena, and his work is referred to repeatedly by the authors. He has shown that some equilibrium diagrams exhibit thermal maxima which do not correspond to rational atomic proportions, while the curves for physical properties do not exhibit the expected discontinuities. Thus, there is much thermal evidence of a compound  $\text{Bi}_2\text{Te}_3$ , while fusion curves and electrical conductivity measurements have demonstrated the existence of a gamma phase between 55 and 65 atonic per cent bismuth—that is, in the same region as the hypothetical compound. This phase exists perfectly independently, but cannot be fitted into any of Roozeboom's types for solid solutions. Further, microscopic examination shows that it undoubtedly possesses the characteristics of a chemical compound. Such facts as these lend support to one of the most important conceptions of recent years—that there exist compounds of variable composition or "chemical individuals," defined by Wald as phases, which in a series

of equilibrium changes possess a notably constant composition.

While, as can be presumed, this book is largely a most useful compilation from a multitude of authorities, the authors present the results of some original, trail-blazing investigations showing that intermetallic compounds generally dissociate upon melting. They studied the lowering of the freezing point of such compounds by the addition of a metal which did not form solid solutions or new compounds, and their conclusions are based upon Van't Hoff's well-known formulas showing the relations between depression and the number of molecules and ions in the liquid.

It is regrettable that such an excellent text should possess such a repellantly-colored binding. The clear typography is poorly matched by the sketchy, undraftsmanlike diagrams, evidently reproduced exactly from the Italian edition, and strangely enough, without captions. Several errors in printing the formulas may be easily noted, but it is indeed a rare book in English which can boast "letter-perfect" in this respect.

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## Personal

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MR. ERLE V. DAVELER is now mill superintendent of the Butte & Superior Mining Co., at Butte, Mont.

DR. HAROLD S. DAVIS has been appointed to the research staff of the H. Koppers Co., Pittsburgh, Pa., one of the largest manufacturers and operators of by-product coke ovens, benzol and toluol plants. Dr. Davis will carry on his work at the Mellon Institute.

MR. FRANCIS N. FLYNN is assistant general superintendent of the Balbach Smelting & Refining Co., Newark, N. J.

MR. JOHN E. GALVAIN has been elected president of the Ohio Steel Foundry Company, Lima, Ohio. He has been operating vice-president since its organization in 1907 and has taken an active part in the organization, having designed and erected the Lima plant.

MR. C. C. GORDON, who is operating a custom smelter near Yauli, in Central Peru, is in the United States investigating chloridizing volatilization processes.

MR. C. J. HALL is now with the Copper Queen Reduction Works, Douglas, Ariz., having resigned his position with the Garfield Smelting Co., Garfield, Utah.

MR. E. C. HICKMAN is now assistant superintendent with the St. Joseph Lead Co., at Herculaneum, Mo. He was formerly with the American Smelting & Refining Co., Murray, Utah.

MR. EDWARD K. JUDD has resigned as managing editor of the Bulletin of the American Institute of Mining Engineers to take a position in the operating department of the American Metal Co., 61 Broadway, New York.

MR. WILLIAM M. KINNEY has been appointed general manager of the Portland Cement Association to succeed Mr. H. E. Hilts, resigned.

MR. OTTO KRESS, who has been connected with the U. S. Forest Products Laboratory, Madison, Wis., in charge of its research work on pulp and paper, is now with E. I. du Pont de Nemours & Co., Wilmington, Del., as director of the new technical dyestuff laboratory in the dyestuff sales department.

MR. JAMES M. MCCLAVE is now president of the Western Research Corporation, 514 Eighteenth Street, Denver, Colo.

MR. BYRON T. MOTTINGER announces that after Jan. 1, 1919, he will be associated as chief engineer and master mechanic with the Quaker City Rubber Co., Wissinoming, Philadelphia, Pa.

MR. A. IRA RENICK has resigned as mill superintendent for the Climax Molybdenum Company, and is now in Anaconda, Mont. Mr. Renick has been succeeded at Climax, Colo., by Mr. O. G. ANDERSON.

MR. FOREST RUTHERFORD, consulting metallurgical engineer, has returned to New York from Colorado.

MR. L. E. SCHUMACHER, who for the past eight years

has been chief inspector of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been promoted to works manager of the Krantz Manufacturing Co. of Brooklyn, N. Y., the latest subsidiary of the former company.

MR. E. GYBON SPILSBURY has been appointed to represent the American Institute of Mining Engineers at the Engineering Congress in Paris. The delegation from the United States, invited by the French Government, is composed of members of the four national engineering societies. These representatives sailed on Dec. 5 and expect to be away about six weeks.

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## Obituary

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MR. H. P. CORLISS, the discoverer of alpha-naphthalamine as a flotation agent, died of pneumonia at Ray, Ariz., on Nov. 16.

MR. EDWARD RANDOLPH, president of the Balbach Smelting and Refining Co., Newark, N. J., died suddenly in his office Oct. 11, 1918.

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## Current Market Reports

### The Iron and Steel Market

Our last review noted that the thought was then rising that the War Industries Board would not indulge in further price fixing, the thought immediately after the signing of the armistice having been that price fixing would continue, even, perhaps, to the extent of fixing minimum prices so as to prevent a slump in the market. This "rising thought" has since become universal. The War Industries Board indicated that it would not fix prices on any material after the present quarter unless urged to do so, with presentation of cogent reasons, and the industry has come to the conclusion that it does not want prices to be fixed.

Market conditions and prospects can therefore be discussed on the basis that there will be no further price fixing by the War Industries Board. The common thought seems to have been, at least until very lately indeed, that such abandonment of price fixing would leave the iron and steel market altogether adrift, and the word "chaos" has even been used. Nothing of the sort. The iron and steel market is left in a very familiar condition indeed, the condition that obtained in the summer of 1900, the second quarter of 1903, the latter part of 1907, the latter part of 1910 and the summer of 1913. In all those cases there had previously been an active demand, the establishment of a relatively high level of prices with an absolutely steady market and full order books, while there was no further buying except for the filling of immediate and pressing wants. To-day the alignment is precisely the same, though of course each time such a situation arises the proportions of the items that make up the situation are somewhat different.

### PHILOSOPHY OF THE STEEL MARKET

The American iron and steel market may have a philosophy of its own. The writer does not know, not being conversant with other philosophies, but the philosophy of the steel market is perfectly clear, and can either be read from plainly recorded history or can be developed from recognized principles, according to whether one prefers the inductive or comparative method of reaching conclusions.

As to the principles involved: First, the iron and steel producers have a large tonnage of business on their books. Some was entered during the period of price control, and therefore at Government prices. Some was entered before the period of price control, at various prices. Speaking in averages, prices before March 1, 1917, were below the Government levels later established, while prices afterward, to the time of Government control, were at higher than Government levels. There is very little tonnage at less than Government prices. Second, there is buying now, by those who want material at once and who do not balk at price because they can turn the material over at once. Third, there is no forward or "investment" buying and no inquiry along that line. Such buyers have no price in mind at which they would take hold if they were quoted the price. Obviously the attractive course for the individual seller would be to maintain existing prices, which are well known and understood. Those who would buy at all would buy more readily at these prices than in an uncertain and declining market. Those who have material due them on contract would much more readily accept it at the contract price than if the market were declining. Nothing is lost and much is gained.

The records are clear that this is precisely what iron and steel producers have done in the past in similar circumstances. In all the five cases cited there was the individual incentive to hold to prices. There was always more or less "team work," in the earlier times helped somewhat by pools and associations and after the collapse of demand in 1907 by the "Gary dinner" system. Those were merely helps, however, the individual incentive being naturally present.

### WHEN WILL PRICES DECLINE?

The immediate question, therefore, is not how far prices will decline but how long it will be before they begin to decline. With prices so high it is not the presence of active demand, but its absence, that operates to maintain the existing price level. There is no incentive to cut, while there is an incentive not to cut, but to nurse the existing contract tonnage on books and effect the largest possible deliveries against it. Some contracts are firmer, legally, than others, but the amounts of money are so large that many buyers would be ruined by taking material at contract prices if a slump in the market made it that their competitors could buy at much less. Of course there may be quiet shading by some producers, but unless pronounced it can be ignored. There was more or less shading throughout 1908, very quiet, and the Gary price maintenance was not formally abandoned until Feb. 20, 1909. When the dwindling of the volume of contract business remaining and the development of a buying disposition needing to be encouraged progress far enough that the balance is tipped and the incentive to cut becomes greater than the incentive not to cut, the market breaks. That break may occur a few weeks after Jan. 1, 1919, or a few months after that date. It will be the most remarkable accident that ever befell the market if it occurs in January. Of course there is a bare possibility of a new and lower level of prices being put out, perhaps under Steel Corporation leadership, in hope of the market being stabilized upon it, but that is extremely improbable.



As indicated in last report, buyers may be divided into classes, according to the period of time in which they are able to reconvert their purchases into cash. It may be estimated roughly that in the steel market as constituted before the war fully one-half the buying was of material for construction purposes intended to return the capital in a period of ten years or more. There can be no such buying at present and the banked up demand of those who can turn over their purchase quickly cannot long keep the industry operating at capacity.

#### BUYER REQUIRES STABLE MARKETS

Obviously the investment buyer is not simply waiting for lower iron and steel prices. If that were all, the producers could easily reach an understanding with him. He wants to know something about what is going to occur in the world, and in particular he requires a stable market for labor and the other materials he must buy, for when steel is bought in the investment sense it requires labor and materials to put it into employment. Sometimes, as in the case of an office building, the steel itself is but a small part of the total cost. In many cases the investment buyer would refuse steel as a gift, if he were required to utilize it at once by buying the other materials and employing the labor necessary to do so.

The delay in the development of investment buying was of course entirely to be expected. In its policy of allowing the mills to continue at work for a time on war steel orders, when the material will hardly be needed, the Government did not contemplate continuing this expenditure until the investment buyer should appear. The policy is an altogether temporary one, to relieve the shock, and the cancellations of orders in process of being filled have been heavier than has been generally reported.

Apart from this necessary delay before regular investment buying is ready to take hold there are two unfortunate circumstances as to steel demand. The first is that the Emergency Fleet Corporation has a large excess of hulls waiting for equipment, launchings having exceeded vessel completions by more than a million tons deadweight, and there is also an accumulated surplus of more than a million tons of plates, represented by the mill shipments minus the plates necessarily in transit or process of fabrication or already entered into hulls. These excesses were an expensive but justifiable factor of safety at one time, but now the program involves greatly reduced plate shipments for account of the Fleet Corporation until a balance is produced. The second unfortunate circumstance is that the railroad problem is in such shape that there is no buyer who can take hold in anything like a free way.

#### RAILROADS IN A QUANDARY

Congress must decide what is to be done with the railroads. The Railroad Administration cannot buy freely, for the roads may be returned to their former owners, who would object to almost any prices paid for steel, as indeed they have objected to prices paid during the war, asking the Government to stand the difference between the price and the post-war value. The individual railroads cannot buy, as they have not the incentive to build up the properties and do not know whether they can afford to buy. The railroads have hitherto

been the steel industry's best single customer, but no buying of real magnitude can occur until something like a decision has been reached as to who is eventually to own and operate the railroads.

Beyond question there will eventually be a heavy demand for iron and steel, chiefly in the great American market rather than for export, and the demand may continue for several years, but there is uncertainty when it will develop. As in geology, the time element is the most uncertain. So it can be predicted that there will be maintenance of the existing prices and declining mill activity, then a break in prices, buying by investors, a rising market again and a sustained period of demand.

#### The Non-Ferrous Metal Market

*Saturday, Dec. 7.*—In general fair stocks of the non-ferrous metals are being held by the consumers, who are not inclined to buy more and feel that by not forcing the market they will be able to replace their stocks more economically later.

*Aluminium.*—The Government prices on ingots 98 to 99 per cent Al are \$660 a ton f.o.b. plant in 50-ton lots; \$662 down to 15-ton lots; and \$666 down to 1-ton lots, which prices will continue the remainder of the year. Prices per pound for small lots vary from 40c. to 45c.; sheet aluminium, 18 ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

*Antimony.*—The volume of sales is not large even at prices from 8½c. to 8¾c. per pound.

*Copper.*—The price of \$520 per ton for carload lots and 27.3c. per pound for small quantities was continued for another period at the conference held on Oct. 25 at Washington. Production declined 3400 tons during November due to the hesitating market conditions. Casting copper is being quoted at 23c. per pound.

Copper sheets, hot rolled..... lb.	\$0.36	—\$0.37½
Copper sheets, cold rolled..... lb.	.37	— .38½
Copper bottoms..... lb.	.44	— .45½
Copper rods..... lb.	.36	— .37
Copper wire..... lb.	.29	— .30
High brass wire..... lb.	.28½	— .29½
High brass sheets..... lb.	.28½	— .29½
High brass rods..... lb.	.26½	— .28½
Low brass wire..... lb.	.32	— .34
Low brass sheets..... lb.	.32	— .34½
Low brass rods..... lb.	.33	— .35½
Brazed brass tubing..... lb.	.37	— .39
Brazed bronze tubing..... lb.	.42	— .44½
Seamless copper tubing..... lb.	.41	— .43
Seamless bronze tubing..... lb.	.45	— .46
Seamless brass tubing..... lb.	.37½	— .39½
Bronze (gold) powder..... lb.	1.00	— 1.75

*Lead.*—Lead has been the first of the major military metals to decline. Transactions are not large and prices at East St. Louis are \$135 per ton and 7.05c. per pound in New York.

*Silver.*—Due to the flow of silver to Asia in payment for munitions and the greatly increasing industrial consumption in photography, motion picture reels and silverware, there is a shortage of silver even at the present government price of \$1.01½ per ounce.

*Tin.*—The Tin Committee of the American Iron and Steel Institute has not yet announced the official price on tin. No doubt an understanding will have to be had with the producers before a final statement can be made public and as they are all in distant foreign countries, considerable time will elapse in intercommunication, with the added possibilities that prices will not be legally fixed but adjusted by economic conditions as to demand by that time. The market is dull at a price of 72½c. per pound.

*Tungsten.*—The buyers of tungsten are decidedly cautious, though there is not likely to be any unlooked-for changes. Prices are nominal, scheelite bringing \$25, wolframite, \$20 to \$21, with no sales of low grade reported.

*Zinc.*—The spelter market continues to be on a firm basis, being little affected by the present transition period. Prime spot, New York, is \$172; East St. Louis, \$165 per ton. East St. Louis, December delivery, \$164; January, \$160; February, \$158, and March, \$157 per ton. Zinc dust, 13½c. to 16c. Sheet zinc, 15c. lb.

## OTHER METALS

Bismuth .....	lb.	\$3.50—\$3.65
Cadmium .....	lb.	1.50—
Cobalt .....	lb.	2.50—\$5.50
Magnesium .....	lb.	1.75—2.10
Mercury .....	75 lb.	120.00—
Mercury .....	lb.	1.95—
Nickel .....	lb.	.40—\$.43
Tungsten .....	lb.	34.00—
Iridium .....	oz.	175.00—
Palladium .....	oz.	135.00—
Platinum .....	oz.	108.00—

## The Chemical Market

**HEAVY CHEMICALS:**—At the present time most chemicals, with only a few exceptions, show very little movement of character. Buyers in the general trade are not disposed to purchase ahead any quantities of material, but are seemingly confining their attentions to immediate needs, which therefore tends to keep business quiet and of a routine nature. While caustic soda has had a flurry of activity, this condition existed only temporarily, with the final disposition on the part of buyers to await developments of shipping space. It is evident that the necessity of cargo space is having a tendency to curtail the volume of trading and whatever stock may be accumulated will be taken up by export demand when this situation becomes easier. Soda ash during the interval has been considerably neglected while the position of bleaching powder has developed more firmly on the recent advance.

**Bleaching Powder:**—The item has had a varied experience; while prices were on the decline for a period, a firming up set in, particularly for material in export drums, which are none too liberal in supply, while trading for domestic drums is somewhat easier. The product in export drums is quoted at 3½c. to 3¾c. works, while that in domestic drums is offered at 2½c. to 2¾c.

**Soda Ash:**—There has been no particular buying interest evident in any of the items that come under this heading and cheap offerings have frequently appeared on the market. Bag material was offered as low as \$2.25 per hundred pounds ex dock, while material from the warehouse was available at \$2.30 to \$2.35, though this price could possibly be shaded on a firm bid. Barrels were subject to no important movement and were held at a variation of prices ranging from \$2.65 to \$2.80 per hundred pounds, though in Chicago offerings were made as low as \$2.55. Double bags from western shipping points were quoted at from \$2.70 to \$2.90, but no particular buying interest was in evidence.

**Caustic Soda:**—The recent announcement of the war trade board, that all restrictions relative to this item have been lifted and that licenses would be granted for any destination, has had a very noticeable effect and prices were advanced from \$3.95 to \$4.20. However, a slackening up set in when the question of cargo space arose and a firm but quiet market has since prevailed. Material from the warehouse was quoted at \$4.20 with \$4.30 being the asking price for F. A. S. delivery. The ground caustic is subject to no important call and is offered at 5c. per pound.

**Permanganate of Potash:**—The lack of buying interest has brought about declines in prices, throughout, and weak holders are seemingly playing havoc with the market, considering the cheap offerings made. The U.S.P. product declined from \$1.75 and \$1.85 per pound to \$1.60 and \$1.70 with virtually no inquiry for the technical product that is quoted at \$1.40 to \$1.50.

**Sodium Acetate:**—Comparatively little interest has been taken lately in this product and the only activity in the market is created by the frequent offerings made. Quotation for carload lots are made at 21c. to 22c. while lesser quantities are offered at 23c. to 25c.

**Zinc Oxide:**—The only interest at the moment is for export purposes while in the local market quietness prevails. Standard brands are being quoted at from 13½c. to 14c.

**Bicarbonate of Soda:**—The firm situation that has been in evidence for this item still prevails, and prices are continued at their former levels. Barrels from the works are offered at 3½c. per pound, while material on the spot is quoted at 3½c. to 3¾c. with the price of keg material being a fraction of a penny higher.

**Nitrate of Soda:**—Restrictions relative to this material have been rescinded and orders are now being accepted for the product, but the entire situation at the moment is by no means easy; however, it is the impression that in January matters will be definitely changed. November prices are \$4.40 ex dock and \$4.52½ ex dock for the 95% and the 96% respectively. The statistical position is as follows:

## PRODUCTION (IN TONS)

	1918	1917	1916
In October .....	239,600	253,400	235,000
For ten months.....	2,317,500	2,419,700	2,381,100

Shipments from the West Coast for October  
(as cabled)

	1918	1917	1916
To Europe, tons .....	60,000	96,100	146,100
To United States, tons .....	254,750	147,700	88,700
To other parts, tons.....	11,600	41,700	51,000

## Shipments from Jan. 1 to Oct. 1

	1918	1917	1916
To Europe, tons.....	806,600	893,700	1,205,150
To United States, tons.....	1,575,050	1,218,400	987,800
To other parts, tons.....	95,200	152,600	211,950

**COAL TAR PRODUCTS:**—With a few exceptions there were no new developments in this market and despite the quietness that has prevailed prices were generally firmly maintained, except in the crude products, of which some have been subject to a decline, particularly toluol, which went down with a swoop, and cheap offerings appeared in the resale market. Many of the intermediates are still in scant supply, which tends to maintain prices, but the consuming trade is not so pressing as to even affect this situation. It appears to be the general attitude on the part of buyers to await developments, and they are inclined to believe the recent occurrences will bring about a reduction in prices. Benzol and phenol have not changed in prices and the governing conditions in this market remain as previously indicated.

**H. Acid:**—The item is one that is now more free in supply, but this condition has apparently been brought about by the lack of buying interest. However, no price concessions are made to encourage business and the situation remains firm.

**Phenol:**—The market has undergone no reportable change; large producers maintain their former prices; however, some weak holders are offering in the resale market 2c. and 3c. below manufacturers' quotations.

**Benzol:**—Quietness prevails in this market and the only movement at the moment is of a routine nature with no desire on the part of purchasers to buy up a surplus stock. Quotations for the commodity in tank cars are subject to no change, which also applies to drum material.

**Paraphenylenediamine:**—The usual trading that is in evidence for this product is reported to be passing, but otherwise no particular interest is noted. There are various grades of the material, therefore a wide range of prices is heard.

**Diphenylamine:**—Spot material is now more liberal and a rather steady volume of business is evident. Otherwise no material change is noted, with prices being firmly maintained.

**Alpha Naphthol:**—Users of this product appear to have eased up buying and stocks are supposed to have accumulated, but producers firmly maintain their prices for both the crude and refined products.

**Aniline Oil:**—While no surface stocks are reported in any one direction, the lack of buying interest has seemingly had some effect on the market and in some instances prices have declined 1c. to 2c.

**Aniline Salts:**—Stocks of this product are more liberal for immediate shipment, but the item appears to be neglected, although dealers up to the present writing have not altered their previous quotations.

**Benzidine:**—Locally there is no important interest displayed in the item, although a fair volume of business is passing for the base product, for export purposes, while the sulphate is lagging. Neither the base or sulphate are subject to any price changes, previous quotations being continued.



## General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET DEC. 6, 1918

Acetic anhydride	lb.	1.60	1.85
Acetone	lb.	.25	.25
Acid, acetic, 28 per cent.	cwt.	5.96	6.11
Acetic, 56 per cent.	cwt.	10.76	10.87
Acetic, glacial, 99 1/2 per cent, carboys	cwt.	19.00	19.20
Boric, crystals	lb.	.13	.15
Citric, crystals	lb.	1.18	1.25
Hydrochloric, C. P.	lb.	Nominal	
Hydrofluoric, 30 per cent, in barrels	lb.	.08	.08
Lactic, 44 per cent.	lb.	.15	.16
Lactic, 22 per cent.	lb.	.06	.07
Molybdic, C. P.	lb.	6.90	7.40
Nitric, 36 deg.	lb.	Nominal	
Nitric, 42 deg.	lb.	.08	.10
Oxalic, crystals	lb.	.40	.43
Phosphoric, 47-50 per cent paste	lb.	.07	.10
Phosphoric, ref. 50 per cent.	lb.	.35	.40
Picric	lb.	.75	.85
Pyrogallol, resublimed	lb.	3.25	3.50
Sulphuric, 60 deg.	ton	16.00	
Sulphuric, 66 deg.	ton	25.00	
Sulphuric, oleum (Fuming), tank cars	ton	60.00	65.00
Tannic, U. S. P., bulk	lb.	1.40	1.50
Tartaric, crystals	lb.	.86	.95
Tungstic, per lb. of W	lb.	1.70	1.75
Alcohol, sugar cane, 188 proof	gal.	4.91	
Alcohol, wood, 95 per cent.	gal.	.91	.92
Alcohol, denatured, 180 proof	gal.	.68	.69
Alum, ammonia lump	lb.	.07	.08
Alum, chrome ammonium	lb.	.18	.19
Alum, chrome potassium	lb.	.20	.22
Alum, chrome sodium	lb.	.12	.13
Alum, potash lump	lb.	.09	.10
Aluminium sulphate, technical	lb.	.02	.02
Aluminium sulphate, iron free	lb.	.03	.04
Ammonia aqua, 26 deg., carboys	lb.	.08	.09
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	.12	.13
Ammonium nitrate	lb.	(Fixed Price)	.15
Ammonium sulphate domestic	gal.	.07	.08
Amyl acetate	gal.	5.30	5.35
Arsenic, white	lb.	.09	.11
Arsenic, red	lb.	.65	.70
Barium carbonate, 99 per cent.	ton	80.00	90.00
Barium carbonate, 97-98 per cent.	ton	65.00	67.00
Barium chloride	ton	70.00	80.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.04	.05
Barium nitrate	lb.	.12	.14
Barium peroxide, basis 70 per cent.	lb.	.30	.32
Bleaching powder, 35 per cent chlorine	lb.	.03	.03
Borax, crystals, sacks	lb.	.08	.08
Bromine, crude	ton	65.00	70.00
Bromine, technical	lb.	.75	
Calcium, acetate, crude	lb.	.04	.05
Calcium, carbide	lb.	.15	.17
Calcium chloride, 70-75 per cent, fused, lump	ton	22.00	24.00
Calcium peroxide	lb.	1.50	1.70
Calcium phosphate	lb.	.22	.23
Calcium sulphate, 98-99 per cent.	lb.	.09	.09
Carbon bisulphide	lb.	.08	.09
Carbon tetrachloride, drums	lb.	.20	.25
Carbonyl chloride (phosgene)	lb.	1.10	1.50
Caustic potash, 88-92 per cent.	lb.	.67	.72
Caustic soda, 76 per cent.	100	4.15	4.25
Chlorine, liquid	lb.		.07
Cobalt oxide	lb.	1.60	1.65
Copperas	lb.	.02	.02
Copper carbonate	lb.	.30	.39
Copper cyanide	lb.	.75	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09	.09
Cream of tartar, crystals	lb.	.68	.73
Epsom salt, bags, U. S. P.	100	3.10	3.40
Formaldehyde, 40 per cent.	lb.	.16	
Glauber's salt	lb.	.02	.03
Glycerine, bulk, C. P.	lb.	.63	.65
Iodine, resublimed	lb.	4.25	4.30
Iron oxide	lb.	.13	.15
Lead acetate, white crystals	lb.	.17	.17
Lead arsenate (Paste)	lb.	.15	.18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	.12	.14
Lithium, carbonate	lb.	1.50	2.05
Magnesium carbonate, technical	lb.	.16	.17
Nickel salt, single	lb.	.14	.15
Nickel salt, double	lb.	.12	.13
Phosgene (see Carbonyl chloride)	lb.	1.10	1.50
Phosphorus, red	lb.	1.17	1.20
Phosphorus, yellow	lb.	1.20	1.25
Potassium bichromate	lb.	.40	.45
Potassium bromide granular	lb.	1.25	1.26
Potassium carbonate calcined, 85-90 per cent.	lb.	.38	.40
Potassium chlorate, crystals	lb.	.38	.40
Potassium cyanide, 98-99 per cent.	lb.	.60	.70
Potassium iodide	lb.	3.75	3.80
Potassium muriate, 80-85 p. c. basis of 80 p. c.	ton	300.00	350.00
Potassium nitrate	lb.	.27	.31
Potassium permanganate, U. S. P.	lb.	1.50	1.75
Potassium prussiate, red	lb.	2.30	2.50
Potassium prussiate, yellow	lb.	.86	.95
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.47	.48
Salammoniac, gray gran.	lb.	.23	
Salammoniac, white gran.	lb.	.22	.24
Salt soda	100	1.40	1.65
Salt cake	ton	18.00	20.00
Silver cyanide, based on market price of silver	oz.	.63	.64
Silver nitrate	oz.	2.40	
Soda ash, 58 per cent, light, flat (bags)	100	3.40	3.60
Soda ash, 58 per cent, dense, flat.	100	Nominal	
Sodium acetate	lb.	.03	.04
Sodium bicarbonate, domestic	lb.		.20
Sodium bicarbonate, English	lb.	.18	.20
Sodium bichromate	lb.	.12	.14
Sodium bisulphite, powd.	lb.	.25	.25
Sodium chlorate	lb.	.30	.35
Sodium cyanide	lb.	.17	.18

Sodium hyposulphite	lb.	3.10	3.50
Sodium molybdate, per lb. of Mo	lb.	2.50	
Sodium nitrate, 95 per cent.	100	4.12	5.00
Sodium nitrite	lb.	.27	.30
Sodium peroxide	lb.	.35	.45
Sodium phosphate	lb.	.04	.04
Sodium prussiate, yellow	lb.	.38	.39
Sodium silicate, liquid (60 deg.)	lb.	.03	.04
Sodium sulphide, 30 per cent, crystals	lb.	.04	.05
Sodium sulphide, 60 per cent, fused	100	.08	.09
Sodium sulphite	lb.	.05	.06
Strontium nitrate	lb.	.25	.30
Sulphur chloride, drums	lb.	.07	.09
Sulphur dioxide, liquid, in cylinders	lb.	.15	.40
Sulphur, flowers, sublimed	100	4.35	4.50
Sulphur, roll	100	3.70	3.85
Sulphur, crude	ton	65.00	70.00
Tin bichloride, 50 deg.	lb.	.28	.29
Tin oxide	lb.	Nominal	
Zinc carbonate	lb.	.18	.20
Zinc chloride	lb.	.15	.15
Zinc cyanide	lb.	Nominal	
Zinc dust, 350 mesh	lb.	.13	.14
Zinc oxide, American process XX	lb.	.12	.14
Zinc sulphate	lb.	.04	.06

## Coal Tar Products (Crude)

Benzol, pure, water white	gal.	22	.27
Benzol, 90 per cent.	gal.	25	
Toluol, in tank cars	gal.	(Fixed Price)	1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55
Xylol, pure, water white	gal.	.45	.55
Solvent naphtha, water white	gal.	.18	.25
Solvent naphtha, crude, heavy	gal.	.12	.15
Cresote oil, 25 per cent.	gal.	.45	.55
Dip oil, 20 per cent.	gal.	.40	.45
Pitch, various grades	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent.	lb.	1.05	1.10
Carbolic acid, crude, 50 per cent.	lb.	.60	.55
Carbolic acid, crude, 25 per cent.	lb.	.35	.38
Cresol, U. S. P.	lb.	.19	.20

## Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	1.10
Alpha naphthol, refined	lb.	1.50	1.60
Alpha naphthylamine	lb.	.55	.60
Aniline oil, drums extra	lb.	.28	.30
Aniline salts	lb.	.41	.43
Anthracene, 80 per cent.	lb.	Nominal	
Benzaldehyde (f.f.c.)	lb.	4.25	4.50
Benadine, base	lb.	1.75	1.85
Benadine, sulphate	lb.	1.40	1.45
Benzoic acid, U. S. P.	lb.	2.50	2.75
Benzoate of Soda, U. S. P.	lb.	2.25	2.50
Benzyl chloride	lb.	2.45	2.50
Beta naphthol benzoate	lb.	10.00	12.00
Beta naphthol, sublimed	lb.	.75	.85
Beta naphthylamine, sublimed	lb.	2.65	
Dichlor benzol	lb.	.15	.20
Diethylaniline	lb.	4.00	4.50
Dinitro benzol	lb.	.36	.38
Dinitrochlorbenzol	lb.	.39	.41
Dinitronaphthalene	lb.	.55	.60
Dinitrotoluol	lb.	.65	.75
Dinitrophenol	lb.	.49	.50
Dimethylaniline	lb.	.73	.75
Diphenylamine	lb.	1.00	1.10
H-acid	lb.	3.25	3.50
Metaphenylenediamine	lb.	1.85	2.05
Monochlorbenzol	lb.	.17	.20
Naphthalene, flake	lb.	.11	.12
Naphthalene, balls	lb.	1.20	1.30
Naphthionic acid, crude	lb.	1.00	1.10
Naphthylamin-di-sulphonic acid	lb.	.45	.50
Nitro naphthalene	lb.	.55	.60
Ortho-amidophenol	lb.	6.50	7.00
Ortho-dichlor-benzol	lb.	.15	.20
Ortho-toluidine	lb.	1.00	1.10
Ortho-nitro-toluol	lb.	.75	.85
Para-amidophenol, base	lb.	4.50	
Para-amidophenol, H. C. L.	lb.	4.25	5.00
Para-dichlor-benzol	lb.	.15	.20
Paranitraniline	lb.	1.75	1.85
Para-nitro-toluol	lb.	1.50	1.60
Paraphenylenediamine	lb.	4.00	4.50
Para-toluidine	lb.	2.25	2.50
Phthalic acid anhydride	lb.	3.75	4.00
Phenol, U. S. P.	lb.	.40	.44
Resorcin, technical	lb.	4.50	5.00
Resorcin, pure	lb.	7.00	8.00
Salicylic acid	lb.	.80	.85
Salol	lb.	1.50	2.00
Sulphanilic acid, crude	lb.	.31	.33
Toluidine	lb.	2.50	3.00
Toluidine-mixture	lb.	1.00	

## Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	
Corning, Ohio	bbl.	2.85	
Somerset, Ky	bbl.	2.60	
Wester, Ohio	bbl.	2.68	
Indiana	bbl.	2.28	
Illinois	bbl.	2.42	
Oklahoma and Kansas	bbl.	2.25	
Caddo, La., light	bbl.	2.25	
Coriscana, Tex., light	bbl.	2.25	
California	bbl.	1.24	1.57
Gulf Coast	bbl.	1.35	
Mexican	bbl.	1.90	
Fuel Oil			
New York	gal.	.15	
Philadelphia	gal.	.10	
Baltimore	gal.	.07	.15
Pittsburgh	gal.	.07	.10
Texas	bbl.	1.85	2.35
Los Angeles	bbl.	1.65	

## Gasoline (Wholesale)

New York, motor	gal.	.244	—	—
Gas machine	gal.	.41	—	—
72-76 degrees	gal.	.33	—	.39
70-72 degrees	gal.	.32	—	.37
67-70 degrees	gal.	.30	—	.36
Pittsburgh, motor	gal.	.25	—	—
Chicago, motor	gal.	.22	—	.23
Oklahoma, motor	gal.	.21	—	—
San Francisco, motor	gal.	.20	—	—

## Paraffine Waxes

Crude, 103 to 105 deg. m.pt.	lb.	.084	—	.09
Crude, 118 to 120 deg. m.pt.	lb.	.094	—	.10
Crude, 124 to 126 deg. m.pt.	lb.	.10	—	—
Refined, 120 deg. m.pt.	lb.	.134	—	—
Refined, 128 deg. m.pt.	lb.	.14	—	—
Refined, 135 deg. m.pt.	lb.	.16	—	.16
Osokerite, brown	lb.	.75	—	.80
Osokerite, green	lb.	.85	—	.90

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.24	—	.25
Cylinder, light	gal.	.45	—	.50
Cylinder, dark	gal.	.39	—	.43
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, 0.903 sp. gr.	gal.	.36	—	.38
Paraffine, 0.885 sp. gr.	gal.	.26	—	.28

## Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	—
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	—
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	—
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	—
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	—
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	—
Wood creosote, ref., f.o.b. Florida	gal.	.31	—	—

## Naval Stores

Rosin A-E barrel	280 lb.	15.25	—	15.60
Rosin F-I	280 lb.	15.60	—	16.00
Rosin K-N	280 lb.	16.00	—	18.00
Rosin W-G-W	280 lb.	18.00	—	18.25
Spirits of turpentine	gal.	.71	—	.73
Wood turpentine, steam distilled	gal.	.62	—	.65
Wood turpentine, destructively distilled	gal.	.58	—	—
Pitch	bbl. 200 lb.	8.00	—	—
Tar, kiln dried	280 lb.	13.00	—	13.50
Retort tar	280 lb.	14.00	—	14.50
Rosin oil, first run	gal.	.80	—	—
Second run	gal.	.83	—	—
Third run	gal.	.88	—	—
Fourth run	gal.	.98	—	—

## Vegetable Oils

Castor oil	lb.	.33	—	.34
China wood oil	lb.	.24	—	.26
Cocoonut oil	lb.	.16	—	.21
Corn oil	lb.	.18	—	—
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.81	—	1.86
Palm	lb.	.18	—	.184
Peanut oil, crude	lb.	.18	—	.22
Soya bean oil, Manchuria	lb.	.17	—	.184

## Glues

Extra white	lb.	.36	—	.45
Cabinet	lb.	.31	—	.40
Brown foot stock	lb.	.18	—	.22
Fish glue, 50-gal. barrels	gal.	1.00	—	1.80

## Miscellaneous Materials

Barytes, floated, white, foreign	ton		Nominal	
Barytes, floated, white, domestic	ton	33.00	—	36.00
Beeswax, white, pure	lb.	.63	—	.65
Beeswax, unbleached	lb.	.43	—	.48
Blanc fixe	lb.	.054	—	—
Casein	lb.	.174	—	.30
Ceylon graphite	lb.	.074	—	.25
Chalk, light, precipitated, English	lb.	.044	—	.06
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f.o.b. mines	ton	28.00	—	40.00
Fluorspar, washed, powdered	ton	90.00	—	—
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Japan wax	lb.	.26	—	.27
Mexican graphite	ton	60.00	—	75.00
Madagascar graphite	lb.	.10	—	.15
Orange shellac	lb.	.72	—	.80
Pumice stone	lb.	.04	—	.08
Red lead, dry, carloads	100 lb.	15.00	—	25.00
Soapstone	ton	.13	—	.14
Stearic acid, 120 deg. m.pt.	lb.	.18	—	.19
Stearic acid, 140 deg. m.pt.	lb.	.20	—	.40.00
Talc, American, white	ton	.094	—	.104
White lead, dry	lb.			

## Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	175.00	—	—
Chrome cement	net ton	75.00	—	—
Clay brick, first quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	110.00	—	125.00
Magnesia brick, 9x4½x2½	per 1000	50.00	—	60.00
Silica brick	per 1000	50.00	—	60.00

## Ferroalloys

Ferrocobaltititanium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y.	ton	200.00	—	250.00
Ferrocobalt	lb.	15.00	—	30.00
Ferrocobalt, per lb. of Cr	lb.	.30	—	.40
Ferromanganese, domestic, 70 per cent basis	ton	250.00	—	—
Ferromanganese, English	ton	325.00	—	—
Spiegelisen (16-18%)	ton	75.00	—	—
Ferromolybdenum, per lb. of Mo	lb.	3.50	—	4.50
Ferrosilicon, 75 per cent, f.o.b. N. Y.	ton	153.00	—	160.00
Ferrosilicon, 50 per cent, contract	lb.	2.35	—	2.40
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	7.50	—	—
Ferroumranium, f.o.b. works, per lb. of U	lb.		—	
Ferrovandium, f.o.b. works	lb.		—	

## Ores and Semi-finished Products

Chrome ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	1.40	—	—
Coke	ton	6.00	—	7.00
Manganese ore, 48 per cent and over, per unit	ton	1.20	—	—
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS <sub>2</sub>	lb.	1.25	—	1.50
Tungsten, Scheelite, per unit of WO <sub>3</sub>	ton	25.50	—	—
Tungsten, Wolframite, per unit of WO <sub>3</sub>	ton	23.00	—	—
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	—
Pyrites, foreign	unit	.17	—	—
Pyrites, domestic	unit	.28	—	.304

## Plant Supplies

## BUILDING MATERIALS

Common clay bricks	M	13.00	—	14.00
Hollow tile, 4x12x12	M	60.00	—	—
Hollow tile, 12x12x12	M	170.00	—	—
Lime	ton	16.50	—	—
Portland cement	bbl.	2.59	—	—
Single glass (82-lb.), 10x26-16x24	ton	21.00	—	27.00
Double glass (164 lb.), 10x26-16x29	ton	31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Fir lumber	M	38.00	—	53.00
Hemlock	M	24.50	—	40.00
Tarred felt (14-lb. sq.)	ton	68.00	—	—
Roofing pitch	ton	27.00	—	—
Asphalt coated roofing (35-55-lb. sq.)	sq.	1.60	—	2.45
Slate surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Putty	100 lb.	6.25	—	—
Red oxide (Ppte. Copperas)	100 lb.	15.00	—	20.00
Native red oxide	100 lb.	3.25	—	8.00
Red metallic paint	100 lb.	1.20	—	1.50
White lead in oil	100 lb.	11.84	—	14.00
Red lead in oil	100 lb.	12.28	—	14.50
Zinc oxide (dry)	100 lb.	13.00	—	14.50
Zinc oxide—leaded	100 lb.	9.00	—	10.00
Yellow ochre	100 lb.	1.50	—	10.00
Ultra marine blue	100 lb.	14.00	—	50.00
Prussian blue	100 lb.	135.00	—	150.00
Chrome green	100 lb.	40.00	—	70.00
Paris green	100 lb.	43.00	—	49.00
Mineral black	100 lb.	1.75	—	2.25
Powdered bone black	100 lb.	5.50	—	12.00
Lampblack	100 lb.	15.00	—	45.00
Gas carbon	100 lb.	16.00	—	25.00
Mexican petroleum pitch	100 lb.	1.00	—	2.00
Glaconite	100 lb.	2.00	—	2.50
Coal tar pitch	100 lb.	.60	—	1.25

## STRUCTURAL IRON

Blue annealed sheet iron	ton	84.00	—	89.00
Black sheet iron	ton	96.00	—	104.00
Galvanized iron	ton	105.00	—	135.00
Tern plate, 8-lb. coating	ton	150.00	—	—
Tern plate, 15-lb. coating	ton	177.50	—	—
Tern plate, 25-lb. coating	ton	200.00	—	—
Tern plate, 40-lb. coating	ton	240.00	—	—
Tin plate, prime	ton	155.00	—	—
Tank plates	ton	65.00	—	65.00
Beams, channels, angles, T's, Z's	ton	60.00	—	70.00
Rivets	ton	88.00	—	92.00
Steel pipe, 1 to 3-inch	ton	51.00	—	—
Bar iron and steel	ton	60.00	—	70.00
Chain (1 inch proof coil)	ton	150.00	—	—
Nails, bolts, nuts, washers	ton	70.00	—	80.00
Tool steels, special alloys	ton	300.00	—	500.00
Bessemer pig iron	ton	36.60	—	—
Bessemer steel	ton	47.50	—	—
No. 2 foundry	ton	37.90	—	—
Steel billets (4 x 4)	ton	47.50	—	—

## POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—	1.10
Asbestos, high pressure	lb.	1.76	—	—
Asbestos, wired	lb.	1.30	—	—
Asbestos, graphited braid	lb.	1.21	—	—
Asbestos, wick	lb.	.75	—	—
Rubber, sheet	lb.	.66	—	—
Cup grease	lb.	.07	—	—
Transmission grease	lb.	.044	—	—
Acle grease	lb.	.044	—	—
Gear grease	lb.	.084	—	—
Cotton waste	ft.	.75	—	.11
Hose, underwriters, 2½ in.	ft.	.50	—	.60
Hose, air, ½ in.	ft.		—	



# INDUSTRIAL

Financial, Construction and Manufacturers' News

## Construction and Operation

### Arizona

**CHLORIDE**—The Schuykill Mining Co. will build a 500-ton concentration plant at its works, to provide for increased capacity.

**DUNCAN**—The Duncan Mining & Milling Co. will build an 80-ton concentration plant.

**DUNCAN**—Harold C. E. Spencer and associates will build a cyanide plant on property five miles from Steeple Rock.

**HUMBOLDT**—The Silver Belt Consolidated Mining Co. will build a reduction plant having a capacity of 100-tons per day. Colonel J. B. Dudley, manager.

**KINGMAN**—The Emerald Isle Copper Co. will build a new leaching plant at its local properties.

**MAYER**—The Orizaba Mining Co. will abandon the old steam surface plant and install distillate or gasoline plant. J. K. Turner, engineer in charge.

**PHOENIX**—The Mount Turnbull Copper Co. is in the market for new machinery and equipment for development. C. B. Barnhard, manager.

**WICKENBURG**—The Octave Mining Co. will build a 250-ton stamp mill at its local properties.

### Arkansas

**ASHLAND**—The Dixie Graphite Co., Jefferson Bank Building, Birmingham, Ala., will build a 200-ton mill and develop the local graphite properties. J. R. Malaney, manager.

**BATESVILLE**—The National Mangane Co. recently incorporated with a capital of \$100,000 will build a washing plant and plans the immediate installation of the necessary equipment for the development of approximately 230 acres of manganese properties. C. A. Enoche, president, and J. L. Elliott, vice-president.

**CUSHMAN**—The Loyalty Mining Co. will build a washing plant and is in the market for a log washer, jigs, belts, shafting, pulleys and mine equipment. Estimated cost, \$10,000. Clarence Edge, superintendent.

**DODD CITY**—The Salina Mining Co. will build a mill and is in the market for crushing and concentration machinery and mine equipment. Estimated cost, \$25,000. E. D. McGuire, superintendent.

**RUSH**—The Ozark Mining & Milling Co., Yellville, will build a 100-ton mill for the handling of zinc and lead ores. E. E. Scofield, manager.

### California

**MARE ISLAND**—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of an oxy-acetylene plant here, to James L. McLaughlin, 234 Kearney St., San Francisco. Estimated cost, \$36,357. Noted Oct. 15.

**REDDING**—The Bully Hill Mining Co. will build a 150-ton flotation plant at its mine. Estimated cost, \$75,000.

### Colorado

**GARFIELD**—The Garfield Mining Co. will build a 50-ton mill at its properties here.

**SUNSHINE**—The Nil Desperandum Mines Co., Box 298, Boulder, will build an oil flotation plant to have a capacity of not less than 50 tons. Estimated cost, \$10,000. M. S. Brandt, president and general manager.

### Connecticut

**NEWINGTON**—Thomas F. Garvan & Co., Church St., Burnside, (Hartford P. O.), will rebuild its paper plant recently destroyed by fire entailing a loss of \$30,000.

### District of Columbia

**WASHINGTON**—The Bureau of Fisheries, Department of Commerce, received bids for the construction of a laboratory building at 7th and B Sts., from Boyle-Robertson Construction Co., 601 Evans Building, \$46,282; James L. Parsons, Jr., 332 Southern Building, \$48,462; A. C. Morse Construction Co., 916 New York Ave., \$48,110. Noted Nov. 30.

### Florida

**KEY WEST**—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build a photo-laboratory here. Specification No. 3692. Estimated cost, \$7000.

**TAMPA**—The Texas Co., 204 Gulf Bldg., Houston, has awarded the contract for the construction of an oil distributing plant, to G. A. Miller, 28 Petteway Blvd. Estimated cost, \$150,000.

**VERO**—The McVey Lindsey Co., Jacksonville, will build a syrup mill to have a grinding capacity of 60 tons per day. Estimated cost, \$15,000.

### Idaho

**BOISE**—The Sewer Department of the City Council is having studies made for the construction of a sewage disposal plant. C. C. Stevenson, engineer.

### Illinois

**CHICAGO**—The Chicago Starch Co., Throop and 27th Sts., has awarded the contract for the construction of a three story, 28 x 45 ft. factory, to Cameron Bros., 115 South Leavitt St.

**CHICAGO**—The Johns-Manville Co., Manville, N. J., has purchased 225 acres of land near the town of Michigan, north of Chicago, and will build a plant for the manufacture of asbestos and magnesia. Estimated cost, \$3,000,000.

**CHICAGO**—The La Salle Steel Co., 2243 South La Salle St., has awarded the contract for the construction of two factory additions on 12th St. and 54th Ave., to Broline & Nolan, 8 South Dearborn St. Estimated cost, \$48,000.

**CHICAGO**—D. A. Stewart & Co., 352 East Illinois St., will build a one story, 100 x 100 ft. factory on 31st St. and Kedzie Ave., for the manufacture of lubricating oil. Estimated cost, \$25,000. R. T. Newberry, 108 South La Salle St., architect.

**CHICAGO**—Swift & Co., U. S. Yards, will build an addition to its soap factory. Estimated cost, \$75,000. C. H. Kane, c/o owner, architect.

**CHICAGO**—Swift & Co., U. S. Yards, has awarded the contract for the construction of a three story, 260 x 300 ft. fertilizer plant, to the Wieboldt Construction Co., 1534 West Van Buren St. Estimated cost, \$550,000.

**CHICAGO**—Wilson & Co., U. S. Yards, will build a three story, 33 x 129 ft. animal oil refinery building. Estimated cost, \$97,000. C. P. Barrett, c/o owner, architect.

**FAYVILLE**—The Aetna Explosives Co., 120 Broadway, New York City, N. Y., will build an addition to its manufacturing plant here.

**GREAT LAKES**—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of an addition to the water distribution system, to Daniel Hardin, 3139 Indiana Ave., Chicago. Estimated cost, \$125,000.

### Kentucky

**IRVINE**—The Mac-Lan Oil Co., Winchester, organized with J. W. McCulloch, Prest., Owensboro and J. H. McClurgin, gen. mgr., Winchester, plans to develop oil land here.

**PADUCAH**—The Wallace Fluorspar Co., recently organized, will develop over 100 acres of local fluorspar properties and is in the market for machinery and equipment for an initial capacity of about 150 tons per day. N. R. Faries, president.

### Maryland

**INDIAN HEAD**—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of improvements to powder factory here, to Scott Brothers, Rome, N. Y. Estimated cost, \$98,605.

### Massachusetts

**BOSTON**—The Air Reduction Co., 120 Broadway, New York City, N. Y., has awarded the contract for the construction of a one story, 60 x 100 ft. plant, to the Austin Co., 217 Broadway, New York City, N. Y. Estimated cost, \$100,000.

**BOSTON**—The General Bond & Share Co., 30 Kilby St., capitalized at \$10,000,000, has taken over the plant of the Chapin Chemical Co., and will establish a large refinery on the property in the Searles Lake potash district.

**NORTH TRURO**—The East Harbor Fertilizer Co., 293 Bridge St., Springfield, will build a two story, 70 x 70 ft. fertilizer plant. Estimated cost, \$40,000.

**SHELBURNE FALLS**—The Mayhew Steel Products Co., 295 Broadway, New York City, N. Y., has awarded the contract for the construction of a factory, to the Austin Co., 217 Broadway, New York City, N. Y. Estimated cost, \$115,000.

### Michigan

**DETROIT**—The Detroit Copper & Brass Rolling Mills, Clark Ave., has awarded the contract for the construction of an addition to its plant, to A. A. Albrecht, Penobscot Bldg. Estimated cost, \$400,000.

**DETROIT**—The Michigan Smelting and Refining Co., 1685 Joseph Campau Ave., will build a one story, steel cupola building. Albert Kahn, Marquette Building, architect.

**WYANDOTTE**—The city will construct a filter plant having a daily capacity of 6,000,000 gallons, composed of 6 filter units, 21½ x 24 ft. of 1,000,000 gallons capacity each; 40 x 65 ft. and 37 x 73 ft. brick and steel filter house and head house; 2 coagulation basins of 64 x 94 ft. each; filtered water reservoir having capacity of 850,000 gallons; usual equipment of hydraulic valves and controllers and 32 x 50 ft. brick addition to pumping station. R. W. Pratt, 232 Jefferson Ave., Detroit, engineer.

### Minnesota

**WORTHINGTON**—The Commissioners of Nobles County have awarded the contract for the construction of a filter plant for the Southwestern Minnesota Sanitarium, to W. Danforth, Germania Life Bldg., St. Paul. Estimated cost, \$13,660.

### Missouri

**ST. LOUIS**—The Mallinckrodt Chemical Works, 2nd and Mallinckrodt Sts., has awarded the contract for the construction of a three story, 70 x 100 ft. plant for the manufacture of ether, to the A. H. Haessler Building & Contracting Co., Wainwright Building. Estimated cost, \$65,000.

### Montana

**BASIN**—The Montana Consolidated Copper Co., 51 Wall St., New York City, N. Y., will remodel concentrator here for the treatment of mine ore and is in the market for rolls, jigs, tables, shafting, belting, motors, pumps, and possibly M. S. flotation machines, etc. Total estimated cost, \$200,000. E. P. J. Burgess, president.

### Nebraska

**OMAHA**—The city will build disposal plant for the Saddle Creek District. J. A. Bruce, city engineer.

### Nevada

**ELY**—The Shepherd Mining Co., operating tungsten properties in the White Pine Section, will build a 15-ton mill.

**LAS VEGAS**—T. Thorkildsen, Trade & Savings Building, Los Angeles, Cal., operating local manganese properties here, will double the capacity of plant which now averages about 200 tons per day.

### New Jersey

**NEWARK**—The F. W. De Voe & C. T. Reynolds Co., Inc., 223 New Jersey Railroad Ave., will build a 105 x 150 ft. plant for the manufacture of paint.

### New York

**BROOKLYN**—The George Washington Refining Co., 147 41st St., will build a

one story, 200 x 400 ft. refining plant. Austin Co., 217 Broadway, New York City, engineer.

**BUFFALO**—The Donner Steel Co., Abbott Rd., will build three one story additions to its plant and a new addition to its plate mill. Estimated cost, \$27,000.

**DUNKIRK**—The Atlas Crucible Steel Co., Howard Ave., will build a one story addition to its plant.

**LONG ISLAND CITY**—The West Disinfecting Co., 411 5th Ave., New York City, has awarded the contract for the construction of a two story, 75 x 125 ft. factory on Bern St. and Jackson Ave., to Walter Bond, 12 Hallett St. Estimated cost, \$25,000.

**NEW YORK**—F. L. Dowling, president of Manhattan Borough, received bids Nov. 26 for furnishing and delivering liquid chlorine, from the Electro Bleach & Gas Co., 13 East 41st St., \$6120; A. Hoffman & Co., Providence, R. I., \$6900; furnishing and delivering sulphate of copper, from J. Grieg, 39 Cortlandt St., \$2901; J. A. Miller, 47 West 34th St., \$2907; Knickerbocker Supply Co., 149 Church St., \$3045.

**POUGHKEEPSIE**—The Palatine Aniline & Chemical Co. will build an addition to its plant for the manufacture of ferro-alloys. Estimated cost, \$40,000.

**MONROE**—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will build a group of radio buildings here. Estimated cost, \$250,000.

### Ohio

**CARROLLTON**—The Robinson Clay Products Co. will build an addition to its plant.

**CASTALIA**—James D. Rhodes, Keystone Building, Pittsburgh, Penn., has been authorized by Judge Charles P. Orr, in the United States district court, to enter into an agreement with the Castalia Portland Cement Co. to experiment with the process by which he can extract potash from the dust from cement during manufacture in the kilns. It is understood that Mr. Rhodes, at his own expense, will erect a large experimental plant, adjoining the plant at Castalia. If the process is found to be of commercial value a \$1,000,000 plant will be erected and the process may be adopted in every cement-producing plant in the United States.

**CLEVELAND**—The Aluminum Castings Co., 2600 Harvard Ave., has awarded the contract for the construction of a one story, 90 x 200 ft. steel and concrete smelting building and a one story, 120 x 280 ft. finishing building, to the J. H. Chaney Co., Hippodrome Building. Estimated cost, \$100,000 and \$150,000 respectively.

**CLEVELAND**—The Ideal Bronze Co., 1265 East 55th St., will build a brick and concrete factory. Estimated cost, \$100,000.

**CLEVELAND**—The Kokomar Co., 455 Leader-News Building, will remodel its former brewery into a feed manufacturing plant where coconut butter, margarine, cereal, etc., will be made. The company is in the market for about \$100,000 worth of machinery.

**CLEVELAND**—The Reflex Ignition Co., 1708 Payne Ave., will build a two story, 50 x 75 ft. brick and concrete factory on West 106th St. Estimated cost, \$25,000.

**CLEVELAND**—The United States Copper Co., Guardian Bldg., will build a steel and concrete copper and brass mill. Estimated cost, \$100,000.

**RAVENNA**—The Oak Rubber Co. will soon award the contract for the construction of a three story concrete and steel factory. Estimated cost, \$100,000. Noted Nov. 30.

**SANDUSKY**—The Libby Glass Co., South Hancock St., will rebuild its plant recently destroyed by fire.

### Pennsylvania

**BETHLEHEM**—The Air Reduction Co., 120 Broadway, New York City, N. Y., has awarded the contract for the construction of a three story, 120 x 200 ft. steel and concrete oxygen plant, to James Mitchell, Inc., 76 Montgomery St., Jersey City, N. J. Estimated cost, \$150,000.

**JOHNSONBURG**—The Rolfe Tannery will build additions to its plant.

**MAHANAY CITY**—The Hercules Powder Co., Du Pont Building, Wilmington, Del. will build a one story addition to its local plant.

### Tennessee

**COLUMBIA**—J. Ogden Armour Fertilizer Co. (branch of Armour & Co., Union Stock Yards, Chicago, Ill.), will build a

phosphate plant near the Century Mines and is in the market for phosphate dryers, washers and grinding plant, for the manufacture of fertilizer material. Total estimated cost, \$550,000.

### Texas

**FORT WORTH**—The Purety Serum Co., incorporated by John Kennedy, vice-president, and J. N. Huff, secretary, with \$150,000 capital has purchased a group of factory buildings here and will remodel same to manufacture serums and vaccines.

**GALENA**—The Petroleum Refining Co. will build additional units at its oil refinery.

**HOUSTON**—The Crown Oil Co. will build an oil refinery on Houston Ship Channel. Estimated cost between \$500,000 and \$1,000,000.

**HOUSTON**—A. E. Fitkin & Co., 141 Broadway, New York City, N. Y., has purchased a site on San Jacinto Bay and will establish an oil refinery for the manufacture of lubricants, to have an initial capacity of 330 barrels of crude oil daily.

**MARFA**—The Capote Nitrate Co., San Antonio, recently organized with a capital of \$100,000, will establish a plant for the production of nitrate of potassium, sodium nitrate, and allied products near here. G. C. Simpson is interested.

**WICHITA FALLS**—The American Refining Co. will build an oil refinery.

### Utah

**PROVO**—The General Reduction and Chemical Co., 23 West 2nd St., Salt Lake City, will build a plant here.

### Virginia

**NORFOLK**—The city will build an addition to its filtration plant; to consist of two concrete filter units. Estimated cost, \$70,000. W. H. Taylor, city manager. Noted Nov. 30.

### Washington

**NORTHPORT**—The Northport Smelting & Refining Co. will build a dressing plant. Estimated cost, \$50,000.

**SPOKANE**—The stockholders of the Loon Lake Rubber Co., Columbia Building, voted a bond issue of \$90,000 for the construction of a mill at its property in Stevens County. Frederick Dewart, National Bank Building, attorney.

**SPOKANE**—The Nabob Consolidated will build a concentrator, having a capacity of 150 tons per day at the old Nabob site and will be reached by the tram moved up from the Stewart property. Address William Beaudry.

### West Virginia

**FAIRMONT**—The Domestic Coke Corp., 1208 Engineers' Building, Cleveland, Ohio, has awarded the contract for the construction of a by-products coke plant, to H. Koppers Co., Union Arcade Building, Pittsburgh, Penn. Estimated cost, \$3,000,000.

### Wisconsin

**DEPERE**—G. Diamond, 2109 Walnut St., Milwaukee, has purchased a 24,000 sq. ft. site here and will build a two story factory, for the manufacture of paper boxes and cardboard.

**SHEBOYGAN**—The city will build a sewage disposal plant.

**WEST ALLIS**—The Prest-O-Lite Co., 619 Trowbridge St., will rebuild its acetylene compressing plant, recently destroyed by an explosion entailing a loss of \$10,000.

### Wyoming

**CASPER**—The Midwest Refining Co. will build six 1000 barrel stills at its local refinery.

### Alberta

**EDMONTON**—The Northland Oil Syndicate will make improvements to its oil plant. Estimated cost, \$50,000. A. Schmidt, Box 301, Edmonton, is interested.

**LETHBRIDGE**—The Imperial Oil Co., Sarnia, Ont., will build an addition to its plant. Estimated cost, \$65,000.

### British Columbia

**GRAND FORKS**—The Consolidated Mining & Smelting Co. will build a reduction plant having a capacity of 100 tons per day at the railroad terminal. Estimated cost, \$37,000. Dan Matheson, superintendent.

**JEDWAY**—The Producers' Mines, Ltd., will install a compressor plant near here. Frank Buckingham, superintendent.

**KAMLOOPS**—W. H. Aldridge, 14 Wall St., New York City, N. Y., will build a reduction plant and a two drill compressor plant, operated by gasoline. P. W. Racey, Vancouver Building, Vancouver, superintendent.

**STUMP LAKE**—The Donohoe Mines, Ltd., Pioneer Building, Seattle, Washington, will build a concentration plant here. F. M. Hawkes, superintendent.

### Ontario

**ARNPRIOR**—Huyck & Sons will build an addition to its plant for the manufacture of paper. Estimated cost, \$20,000.

**BELLELEVILLE**—The Belleville Rubber Co., Ltd., has been incorporated by Wilson S. Morden, 12 King St., Toronto, Ernest W. McNeill, 350 Spadina Road, Toronto, and others with \$1,000,000 capital stock to manufacture rubber, rubber goods, etc.

**CHATHAM**—The Waterworks Commission will install a laboratory to enable it to make daily bacteriological tests on the city water.

**LONDON**—The Société Liquide Air, Montreal, Que., will build a brick factory and is in the market for machinery for acetylene work. Estimated cost, \$75,000.

**TORONTO**—The Alloy Steel Works, Ltd., 400 Front St., will build a two story addition to its plant.

**TORONTO**—The Canada Metal Co., Fraser Ave., will build a one story brick addition to its plant. Estimated cost, \$15,000.

**TORONTO**—The Gutta Percha & Rubber Co., 130 O'Hara Ave., will build an addition to its plant. Estimated cost, \$5000.

**TORONTO**—The Matthews Packing Co., Bathurst St., will build a new fertilizer plant. Estimated cost, \$55,000.

**TORONTO**—A. Harris, works commissioner, has recommended to the City Council that a Wallace and Tiernan liquid chlorine plant be installed at Toronto Island. He states that a considerable saving of sulphate of alumina will be thus effected at the filtration plant. Estimated cost, \$3000.

**WINDSOR**—The city plans an election January 1, to vote on a bond issue of \$250,000 for the construction of a sand filter having a daily capacity of 12,000,000 gallons. R. W. Pratt, Hippodrome Building, Cleveland, Ohio, engineer.

### Quebec

**OUTREMONT**—McArthur Irwin, Ltd., 20 St. Paul St., W., Montreal, will build a plant for the manufacture of paints, oils, and chemicals. Estimated cost, \$60,000.

**THREE RIVERS**—The Canada Iron Foundries, Ltd., St. Maurice St., has awarded the contract for the construction of a one story brick extension to its plant, to Robert, Dugre & Arseneault. Estimated cost, \$75,000.

## New Publications

**BUREAU OF STANDARDS TECHNOLOGIC PAPER No. 110** entitled "Influence of Quality of Gas and Other Factors on the Efficiency of Gas-Mantle Lamps." By R. S. McBride, W. A. Dunkley, E. C. Crittenden and A. H. Taylor.

**NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY, Economic Paper No. 48.** "Forest Fires in North Carolina During 1915, 1916 and 1917 and Present Status of Forest Fire Prevention in North Carolina." By J. S. Holmes.

**UNITED STATES NATIONAL MUSEUM, Bulletin 192, Part 5**, of the Mineral Industries of the United States entitled "Power: Its Significance and Needs" by Chester G. Gilbert and Joseph E. Fogue.

**POTASH AS A BY-PRODUCT OF THE CEMENT INDUSTRY.** By Richard K. Meade, Baltimore, Md. This booklet is a reprint of articles appearing in "Rock Products" in the July 17 and 31 and Aug. 14 and 28th issues, 1918.

**NEW BUREAU OF MINES PUBLICATIONS:** Bulletin 160: Rock Quarrying for Cement Manufacture. By Oliver Bowles. Bulletin 171: Melting Brass in a Rocking Electric Furnace. By H. W. Gillett and A. E. Rhodes. War Minerals Investigations Series No. 4 dated Nov. 1918. Note on The National Importance of Allocating Low-ash Coke to the Manganese-Alloy Furnaces. By P. H. Royster.





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Christmas Roll Call?

### *Universal Membership*

## The Goal of the Red Cross Christmas Roll Call



The aim and underlying purpose of this campaign is to recruit under the banner of the Red Cross every loyal American no matter where he or she may live. "A large membership in the Red Cross means more 'Over There' than money," said Chairman Henry P. Davison upon his return from a visit to every battle front. It is hoped and expected that this great ambition will be realized. It can be if every patriotic man and woman makes it their responsibility to get universal membership in the Red Cross.

The object of the Red Cross Christmas Roll Call is to register in terms of active participation the spirit of a nation. The spirit in question is personified in Red Cross membership. Everyone is urged to make it unanimous.

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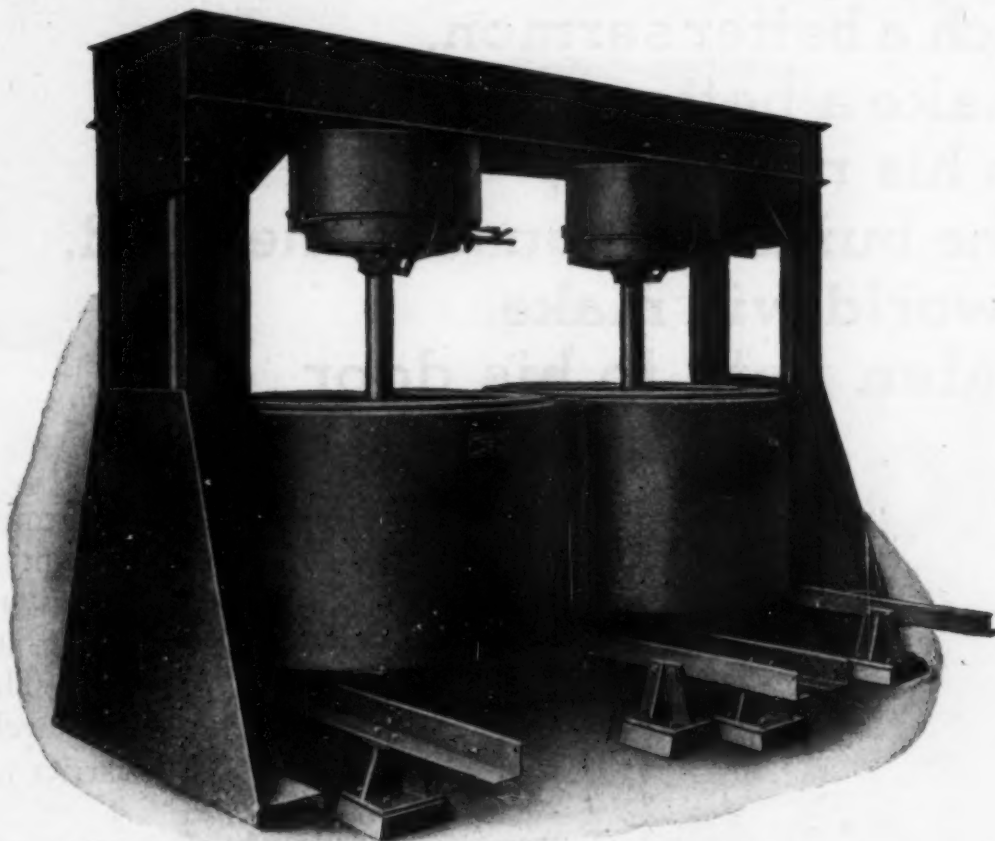






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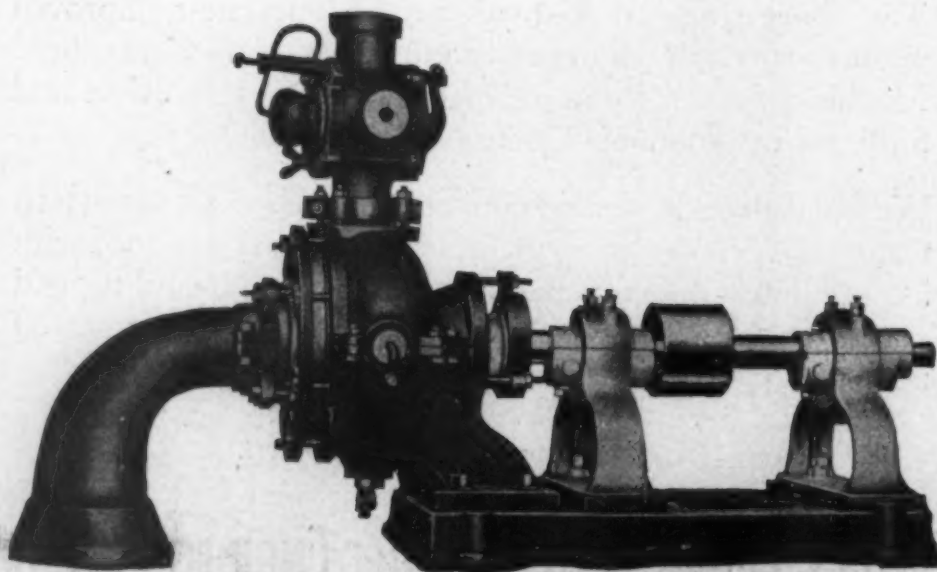
HAVANA OFFICE  
Cuba 84

# IF A MAN

write a better book,  
preach a better sermon,  
or make a better mouse trap,  
than his neighbor,  
tho he build his house in the wood,  
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So states one prominent manufacturer. If you have the same problem to overcome remember that

### HEAVY, IMPURE AIR

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A Sirocco System furnishes pure air, at a specified condition. It gradually increases or decreases humidity, purifying, heating, cooling, washing or otherwise treating the air.

Let us send you a Sirocco Booklet.

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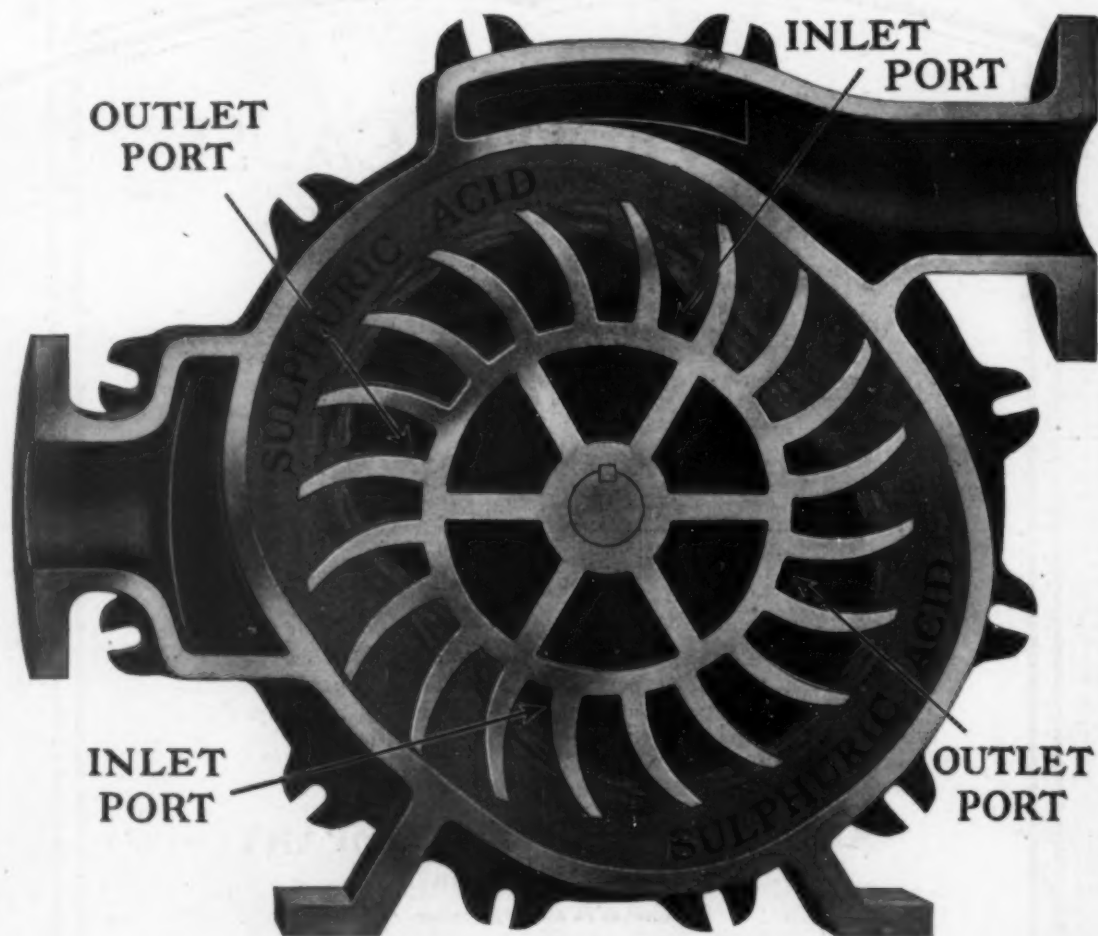
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THE SIMPLEST AIR COMPRESSOR  
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## Principle of Operation

The water revolves with the rotor but follows the elliptical casing due to centrifugal force. Twice in a revolution the water alternately recedes from and reenters the rotor.

## The Water Acting as a Piston Compresses the Air

The Hydroturbine contains but one moving part, the rotor, which is cast in one piece, with blades reinforced by shrouds cast integral. The rotor is firmly keyed to a substantial shaft which rotates on heavy annular ball bearings mounted outside of casing. The air is thoroughly washed during compression and contains no oil, as the Hydroturbine requires no interior lubrication. Air is delivered by the Hydroturbine without pulsation.

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**Gives More Satisfactory Service  
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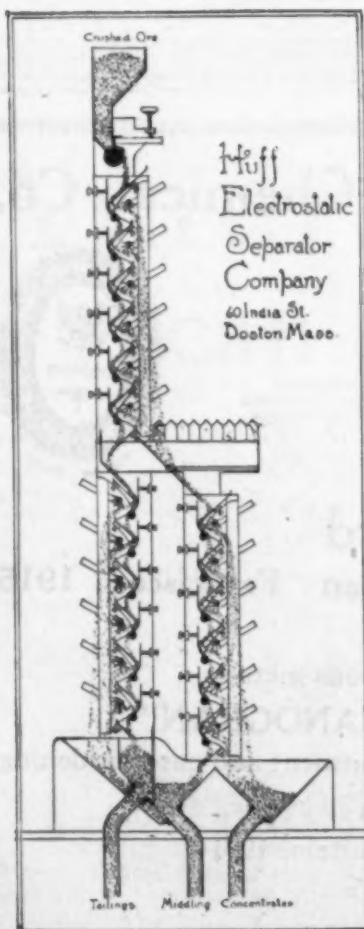
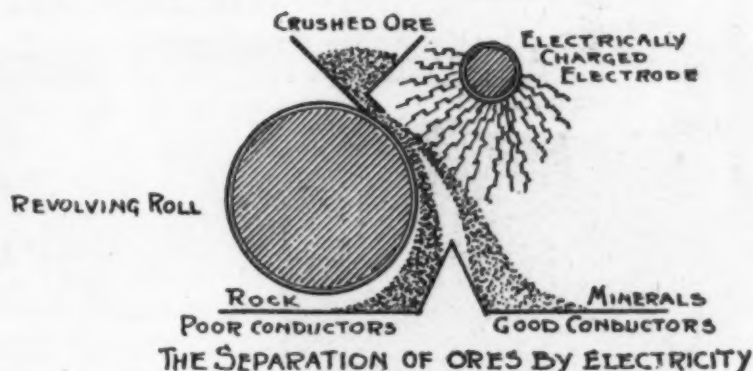
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This method of concentration has long since passed the experimental stage, and is in extensive use by a number of large mining companies. We do not claim that it is the best method in every case; but with the majority of ores brought to our attention we have been able to make more effective and economical separations than would otherwise be possible.

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ETERNIUM anti-corrosive Paint instantly arrests the action of dilute acids, alkalis, or the vapors of steam, gases and chemicals. It is a scientific, high-grade, black coal-tar paint, easily applied and quick-drying.

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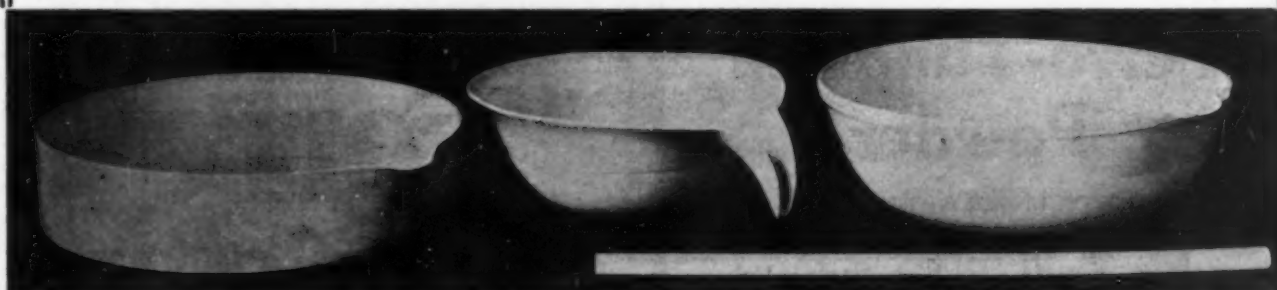
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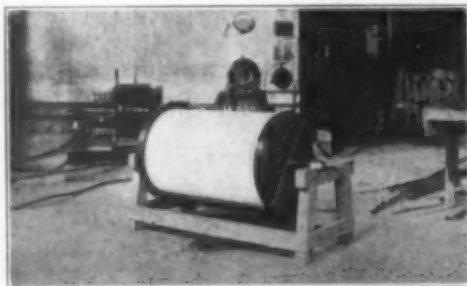
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YOUR  
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are  
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We claim of this type

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Saving 50% floor space. Automatic regulation of temperatures. Highest cell efficiency. Low cost of installation. Minimum cost of maintenance.

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No. 13

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**CHEMICAL USES OF  
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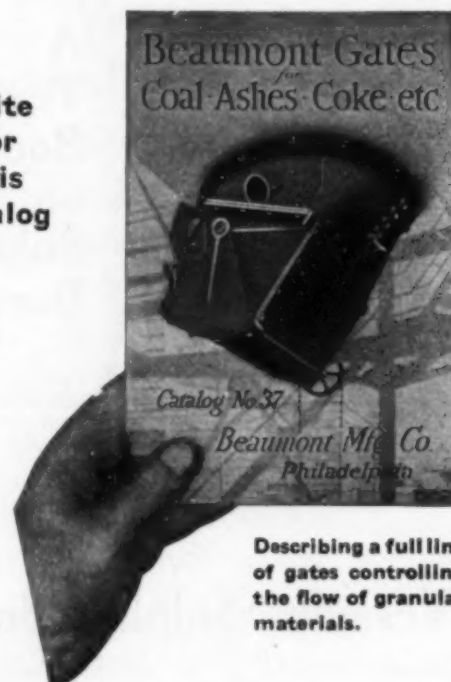
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Pruden Process of burning powdered coal  
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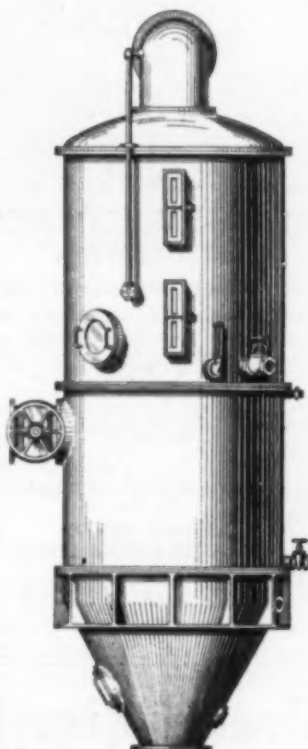
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Vertical Tube  
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Temperature  
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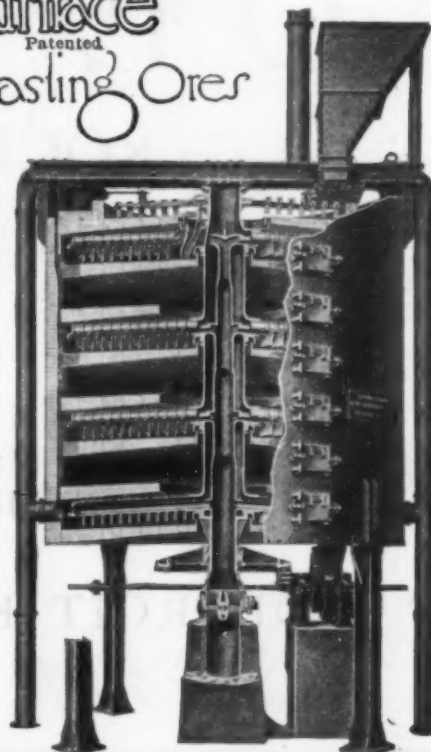
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(Patented)

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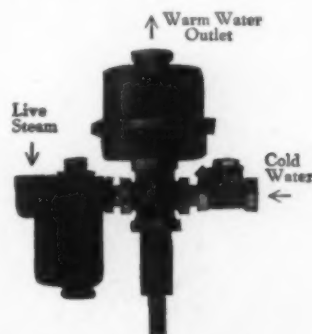
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The Powers Thermostatic Steam and Water Mixer is an ideal water heater, especially where hot water is used only at intervals—as for workmen's wash sinks.

It supplies warm water, whenever wanted, at any desired temperature, without any danger of scalding.

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The smallest opening thru the trap determines this.

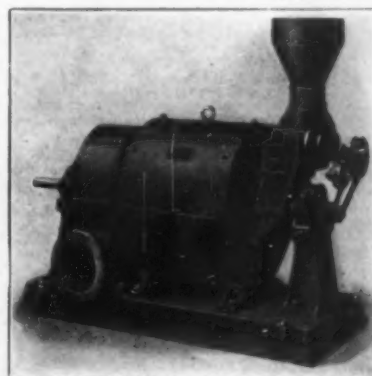
The BUNDY has a Globe valve which opens to give an area more than equal to the pipe connections.

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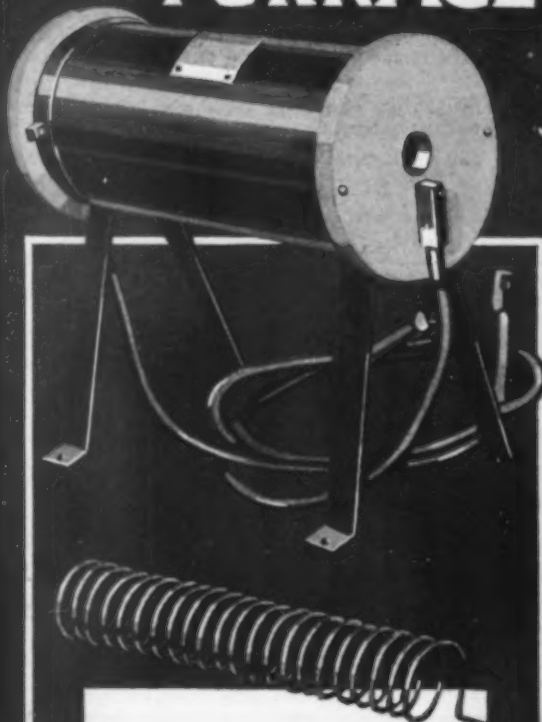
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The furnace shown here is built for hard, continuous service at the temperatures used in making Carbon Combinations.

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This furnace, known as the FB Type, operates only on alternating current of low voltage, and requires use of transformer. Reaches 1100° C. in about 30 minutes and draws 1 K.W. as maximum load.

The insulation is in bonded form and stays in place when heating-unit is renewed.

Also made in Muffle design.

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### Tests for Royal Copenhagen Porcelain

Heating with water for 6 hours at 100° C. No loss in weight.

Heating double Normal HNO<sub>3</sub> for 3½ hours. No loss in weight.

Heating double Normal NaOH for 3 hours. No loss in weight.

Plunging cold dish in muffle at red heat. No fracture.

Heating to 1100° C., with sand. Sand did not stick.

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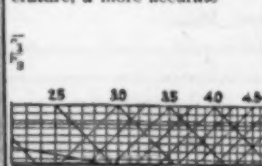
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Chem. & Met. 12-15-18

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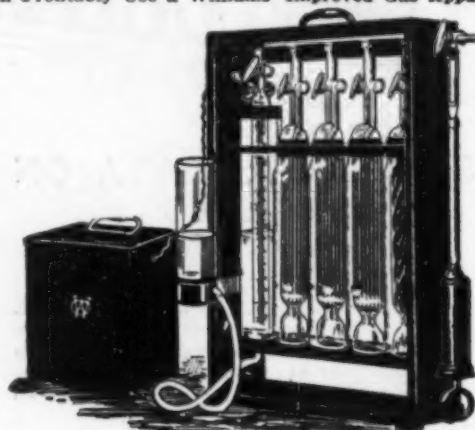
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MODEL A.

For complete analysis of combustible gases. Especially adapted for determination of corrosive gases, chlorine, hydrochloric acid, sulphur oxides, etc.

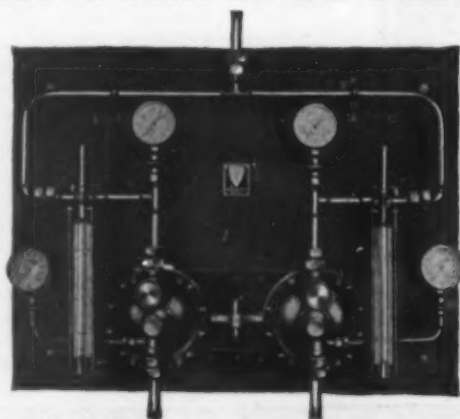
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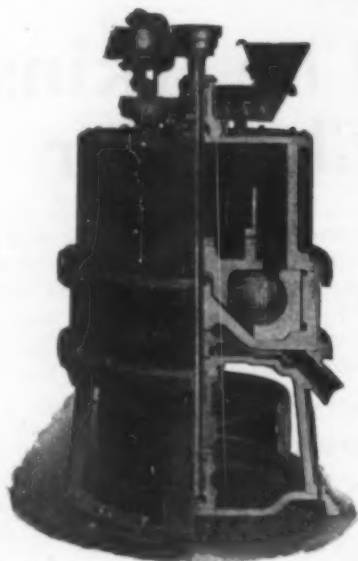
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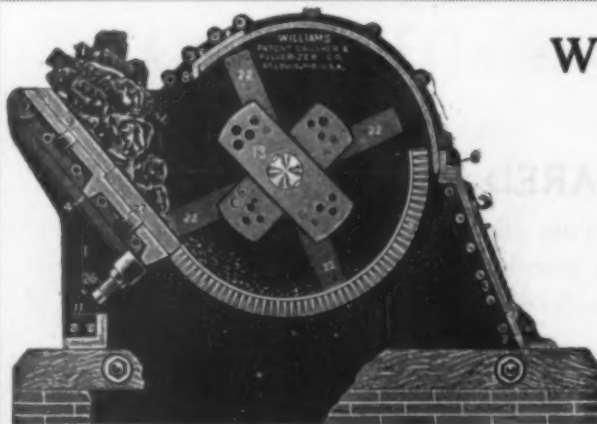
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Bone Black	Foundry Facing	Magnesite	Slate
Carbon	Fullers Earth	Marble	Talc
Cement Rock		Ochre	Tripoli
Cement Clinker	Glass	Ores	Tufa
Chalk	Gold Quartz	Oyster Shells	Umber
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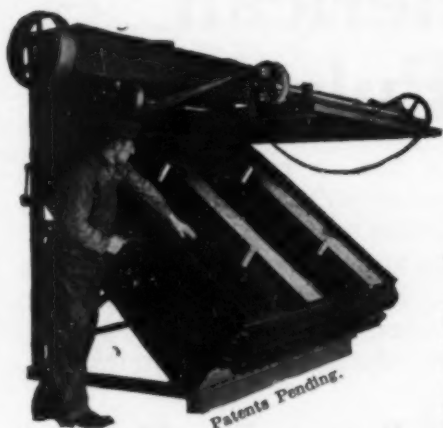
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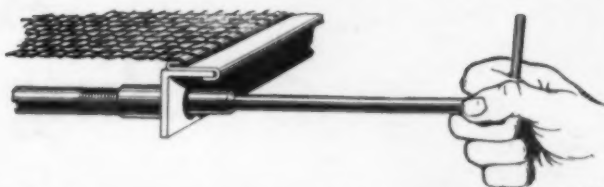
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SCREENS ANY DRY MATERIAL  
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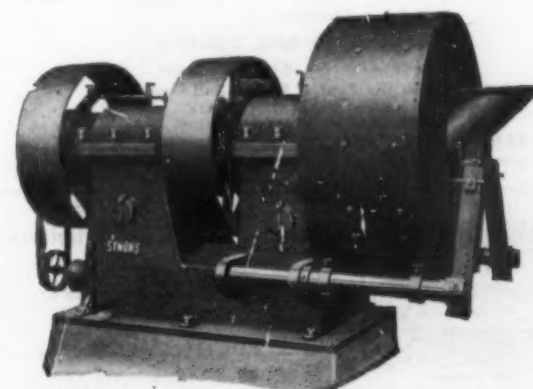
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**It is the only crusher** which will take the rejections, screened or unscreened, from large standard gyratory crushers and effect a reduction rapidly at one operation to  $\frac{3}{4}$  inch or less.

**It is the only crusher** which spreads the



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**It is the only crusher** equipped in every case with manganese steel crushing members.

*Users of Symons Disc Crushers do not  
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Especially effective on 80% Ferro Manganese. Use it for shale, kaolin, coke, coal, lime, limestone, gypsum, sandstone, gravel, brickbats, quartz, pyrites, phosphate rock, oyster shells, slag, electrodes, ore, feldspar, etc.

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Front view

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Magnetic Separators

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CINCINNATI, OHIO

## The K-B Pulverizer

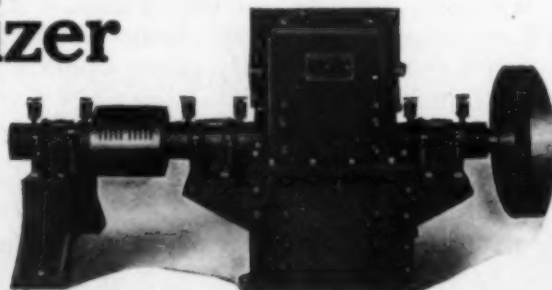
is a power saver  
and built to last

Crushes 3-in. pieces to dust in one operation.

Send for full particulars.



**K-B PULVERIZER CO., INC., 86 Worth St., New York**

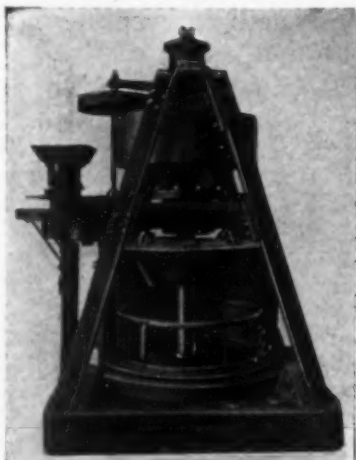


## FINE PULVERIZING MACHINERY

Pulverizing of refractory materials to 95% thru 100 mesh; 82% thru 200 mesh in single operation.

Coal, Coke, Limestone, Cement Rock and Clinker, Phosphate Rock and other materials of a refractory nature.

*Immediate deliveries for essential purposes.*



**BRADLEY PULVERIZER CO.**  
Boston London Works: Allentown, Pa.

## PULVERIZED COAL EQUIPMENT

AERO PULVERIZER CO., 120 BROADWAY, N.Y.

## Aluminum Company of America PITTSBURGH, PA.

### Manufacturers of ALUMINUM

Ingot, Sheets, Tubing, Wire, Rod, Rivets, Moulding  
Extruded Shapes, Electrical Conductors

General Sales Office, 2400 Oliver Building, Pittsburgh, Pa.

#### Branch Offices:

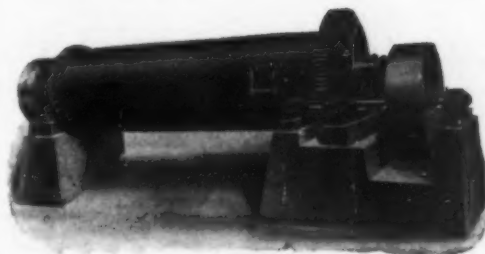
Boston.....131 State St.	New York.....120 Broadway
Chicago.....1600 Westminster Bldg.	Philadelphia.....1218-1219 Widener Bldg.
Cleveland.....660 Leander-Noyes Bldg.	Rochester.....1112 Granite Bldg.
Detroit.....1612 Ford Bldg.	San Francisco.....781 Rialto Bldg.
Kansas City.....206 N. A. Long Bldg.	Washington.....417 Metropolitan Bank Bldg.

CANADA  
Northern Aluminum Co.  
Ltd., Toronto.

LATIN AMERICA  
Aluminum Co. of South America  
Pittsburgh, Pa.

ENGLAND—Northern Aluminum Co., Ltd., London.

Send inquiries regarding aluminum in any form to nearest Branch Office, or to General Sales Office.



Abbé Tube Mill—Patented  
Trunnion Style

# SERVICE

A word often abused—but with us something we have lived up to, the kind of service which results in repeat orders—satisfaction.

# ABBÉ

Engineering Co.

## Reduction Machinery

### 59 Sizes

### 30 Designs

A large enough variety to enable you to choose the machine best suited to your purpose. A Tube Mill or a small pebble mill, whichever you need, you may be assured it is the best that conscientious management and first-class workmanship can produce.

#### Ours Is Your Testing Laboratory— Use It.

We have over a dozen different mills set up here ready to crush, cut, grind or mix either wet or dry any product for you without charge. Send a sample of material, a few ounces or any weight up to a hundred pounds. We'll grind it for you and send a full report with advice as to machine most suitable for your work. All we ask is that you pay the shipping charges on the samples.

Large Capacity

Low Power

Continued Operation

Satisfactory Service

Low Upkeep

Uniform Results

## ABBÉ Engineering Co.

218-220 Broadway, New York

## Accurate, automatic, continuous weighing in mixing and compounding operations

It would require several men, shoveling, weighing and dumping without let up, to equal the amount of work done by

# The Poidometer

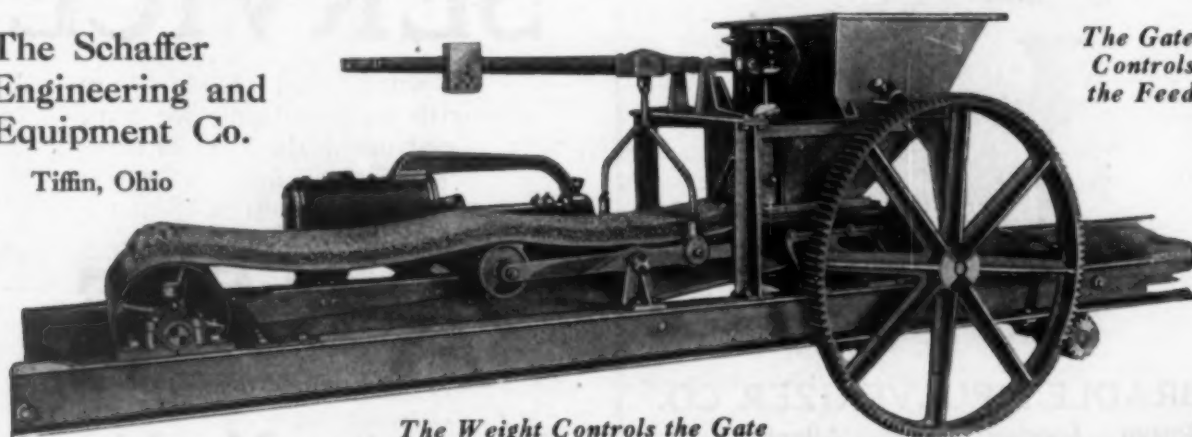
For setting up different materials, one machine is used for each material adding the different ingredients in correct proportions. All operations are automatic. If any one ma-

chine runs out of material the entire battery stops automatically, preventing mixing in unequal proportions.

*Send for Bulletin No. 5.*

**The Schaffer  
Engineering and  
Equipment Co.**

Tiffin, Ohio



*The Gate  
Controls  
the Feed*

*The Weight Controls the Gate*



## Wet or Dry

Hot or cold, coarse or fine materials can be thoroughly and economically mixed in one of the various types of "Gardner" Mixers.

No matter what your sifting and mixing problems may be we have the machine to handle them.

*Catalogue on request. Shall we send one?*

**The Gedge-Gray Company**  
Lockland, Ohio

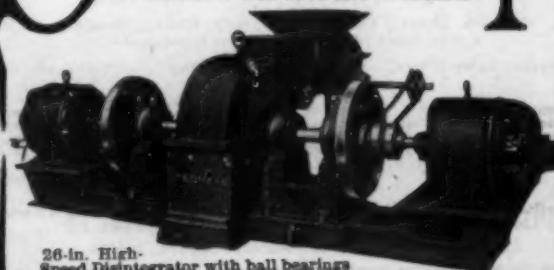
# STEDMAN DISINTEGRATORS

## MOTOR DRIVEN AND BALL BEARING

These Disintegrators are largely used by Chemical Manufacturers for grinding their different materials. We make a specialty of machinery for the Fertilizer Branch of the Chemical Trade for the manufacture of Complete Fertilisers.

Write for our Catalogs Nos. 12, 14 and 15 and Bulletin 193 describing our line of crushing, grinding, mixing and screening machinery.

**Stedman's Foundry & Machine Works**  
Aurora Established 1834 Indiana



26-in. High-Speed Disintegrator with ball bearings







**1,000,000**  
vs.  
**18,000**

is the difference between the average yearly immigration before the war and last year.

Practically the same condition has existed for four years.

This represents a fundamental labor shortage that is not affected by the return to their old jobs of army men—when-ever that may occur.

It is only one of the reasons why construction costs will not fall off much and why construction programs should not be long postponed.

We are ready to do our share as

*Designers of*

Plants for Chemical and Industrial Manufacture, and especially for Sulphuric, Muriatic, Nitric and Acetic Acids; Chemical Salts, Paint, Lithopone, Blanc Fixe, White Lead, and Stackless Varnish Plants, Leak-Proof All-Masonry Construction for Chemical Treatment Towers.

Prevention or elimination of Dust, Fume and Odor.

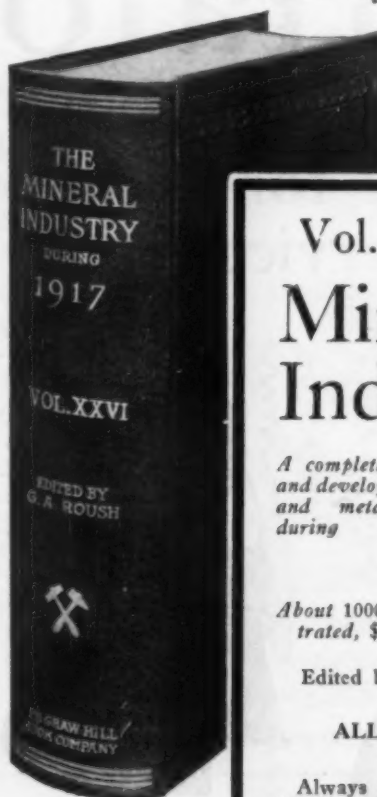
Complete designs and license for the

**Kalbperry Tower Concentrator**

For the concentration of Sulphuric Acid to any strength up to 97%, Phosphoric Acid, and for other liquids and chemical solutions. In successful use for twelve years, and adopted in many plants throughout the country.

*The*  
**KALBPERRY CORPORATION**  
*Chemical & Industrial Engineers*  
**31 UNION SQUARE WEST**  
**NEW YORK, N. Y.**

*Of special value this year  
when the market and  
sources of supply are  
in chaotic  
condition*



**Vol. XXVI**  
**Mineral Industry**

*A complete review of progress and developments in the mineral and metallurgical industries during*

**1917**

*About 1000 pages, 6 x 9, illustrated, \$10.00 net, postpaid*

Edited by **G. A. ROUSH**  
AND  
**ALLISON BUTTS**

Always the first to give reliable world data and statistics for the previous year.

Every article is the work of a specialist. Every commercially valuable metal is covered in alphabetical order fully and authoritatively.

This annual is international in character. It gives, so far as is possible, sources of supply and statistics of production for the various countries of the world, and discusses markets and commercial possibilities.

It is an indispensable reference book for metallurgists, mining engineers and chemists.

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M-12-15-18



# Buffalo

## Fans, Blowers and Pumps for Acid Service

This direct - connected little blower is one of the handiest ever made for blowing forge fires, exhausting gases and fumes, dust from small grinders and buffing machines, blowing scale for power hammers and chips and sawdust from woodwork- ing machinery.



"Buffalo" Acid Fans, Blowers and Pumps can be built of any metal or alloy that is most suitable for the special work demanded of them—cast iron, lead, bronze, monel metal, copper, tin, aluminum, etc.

Our long experience in building acid fans, blowers and pumps enables us to build the type of equipment best suited to meet YOUR requirements.

Consult with us before buying. Our engineering department will be glad to give you complete information. Write to Department 55.

**Buffalo Forge Company**  
Buffalo, N. Y.

## CHEMICAL PLANT EQUIPMENT

### Lifting Liquids

Syphons, Iron  
Syphons, Lead Lined  
Syphons, Stoneware  
Air-Jet Lifts  
Auto. Blow Cases  
Centrifugal Pumps

### Moving Cases

Exhausters  
Rotary Fans  
Compressors  
Spray Nozzles  
Blast Nozzles  
Vapor Condenser

### Valves

Angle, Lead Lined  
Globe, Lead Lined  
Globe, Diaphragm  
Float Valve, Lead  
Swing Check Valve  
Ball Check Valve

### Miscellaneous

Heaters  
Strainers  
Agitators  
Lead Fittings  
Boiler Injectors  
Sulphur Furnace

*Use Our Chemical Department*

**SCHUTTE & KOERTING COMPANY**

1237-59 North 12th St., Philadelphia, Pa.



**LARAGE**  
FANS-BLOWERS  
HEATERS-ENGINES  
KALAMAZOO-MICH  
NEW YORK - CLEVELAND - CHICAGO

## THE KROGH The most widely used Sand Pump

Its special chilled car-wheel iron liners and moderate speed reduce costs and save trouble. Send for the Krogh Sand Pump Bulletin.

Krogh Pump Mfg. Co., 145 Beale St., San Francisco, Cal.

**ELMORE**

**Acid-Proof Centrifugal Pumps**

Valve made of chemical stoneware. Impeller and stuffing box acid-proof strong construction, built for continuous operation. Size: 1 to 3-in. discharge.

Write for full information, prices and guarantee.

G. H. ELMORE, Philadelphia, Pa.

## CONNEERSVILLE

Blowers, Gas Pumps, Water,  
Vacuum and Liquor Pumps.

**THE CONNEERSVILLE BLOWER CO.**

Connersville, Ind.

Chicago, 929 Monadnock Bldg.

New York, 114 Liberty St.

S-A

## BELT CONVEYORS

**Save Lubrication.** The Unit Carrier ball-bearings are filled with grease before shipment and will run for months without further attention.

**Reduce Belt Wear.** One-third of the ordinary friction resistance of the belt is eliminated by the ease with which the belt slides over the easy-turning steel rolls.

**Are Adjustable.** The flexibility of the Unit construction allows adjustment to every possible condition, and makes S-A conveyors adaptable to every purpose.

**Reduce Power Consumption.** The ball-bearings on which the rolls are mounted, and the accuracy with which the entire Unit Carrier is constructed, reduce power consumption from 10 to 30%.

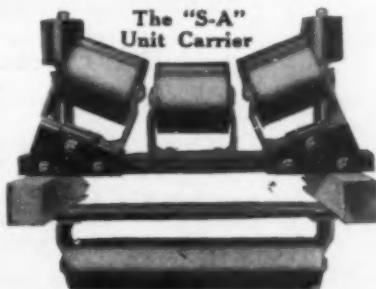
Write for the "S-A" Catalog

**Stephens-Adamson  
Mfg. Co.**

Conveying, Screening and Transmission  
Machinery

Aurora, Illinois

The "S-A"  
Unit Carrier



## EASTON INDUSTRIAL RAILWAY CARS

## Obvious Advantages



A MAN can handle twice as much material in a wheelbarrow on a smooth, clean, concrete floor as he can on an earth floor, and about 18 times as much as he can on sand.

Without multiplying cases the advantages of the steel to steel contact of Industrial Railway Cars and Track must be obvious. Especially so if the cars and equipment are properly designed and installed.

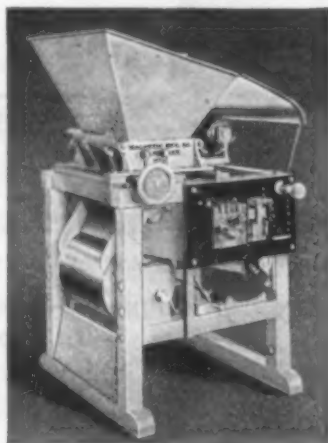
This Company's quarter century of manufacturing specialization and the services of its engineering force will assure for you the highest type of Industrial Railway.

## EASTON CAR &amp; CONST'N CO.



26 CENTER SQUARE, EASTON, P.A.  
New York      Boston      Detroit      Chicago      Philadelphia      Pittsburgh

*A Customer Says:*  
*"The No. 1, Type L, Magnetic Separator has given entire satisfaction."*



Type L  
Magnetic  
Separator.

### We Quote

at the top and bottom of this advertisement the opinions of two users of our

### Type L Magnetic Separator

You will note that these users, after actual trial, refer to it as having given "entire satisfaction" and having "proven an extremely efficient machine."

These expressions have all the force of truth based on knowledge. They are from users and they sum up the results of actual use of the machine—always the final test.

**Standard Machines.** Our Type "L" Machine is only one of our standard separators. We also build standard high intensity machines for Mine Smelters and Reduction Plants. Send for Bulletin 30.

**Special Machines.** We are prepared to furnish estimates and plans for magnetic separator to do any special work capable of being done by means of magnetic separation.

### You Can Prevent Accidents

and needless wear on your crusher by using the

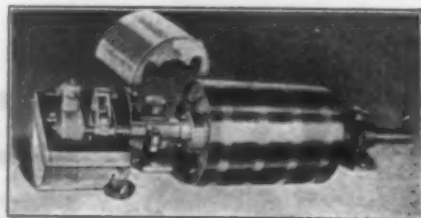
### M-M-C Magnetic Pulley

Extracts automatically odd bits of iron and steel from material before it reaches the crusher. Can be used with any ordinary conveyor belts and is guaranteed for one year. Write for Bulletin 25.

### Magnetic Manufacturing Co.

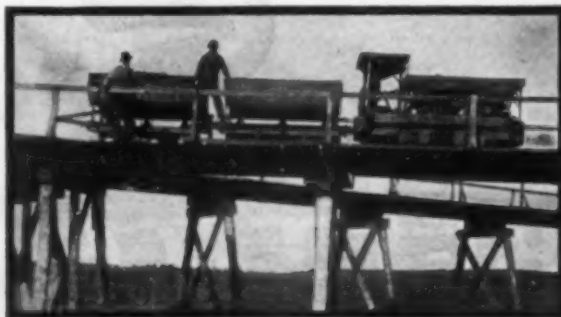
Fourth and Windlake Ave.

Milwaukee, Wis.



M-M-C Magnetic Pulley

*A Customer Says:*  
*"The No. 2, Type L, Magnetic Separator has proven an extremely efficient machine."*



### Forty Degrees Below— Right on the Job!

**I**N its huge task of furnishing iron and steel to the world, America looks for a big part of its supply to the big ranges of the North.

Just how the PLYMOUTH Gasoline Locomotive is helping one of these producers, the Sultana Mines Co., of Ironton, Minn., is interestingly shown in their letter saying that, for two seasons, they have kept the outfit profitably busy throughout the winter.

### "Couldn't Do Without the PLYMOUTH Locomotive; Used it on Stockpile During Two Very Severe Winters"

writes Superintendent O. C. Montgomery, who adds that, after this thorough-going experience, they have found the PLYMOUTH very satisfactory, and an excellent investment.

In doing big tasks smoothly, easily and economically, and in taking over smaller ones formerly done by hand, PLYMOUTH Gasoline Locomotives have shown themselves "the machines of the hour" in plants of almost every kind all over Industrial America.

PLYMOUTH Gasoline Locomotives are easy to buy and to operate; their simple construction enables you to put them into the hands of even comparative novices; and their great power-range makes possible the doing of whatever comes up in the day's work.

Their services cover everything from the hauling of a few hundred pounds, up to moving and "spotting" freight cars for loading and unloading. PLYMOUTH Locomotives are made in two sizes, 3-ton and 6-ton.

### Let PLYMOUTH Help With Your Moving and Hauling

PLYMOUTH Gasoline Locomotives have a clean record of good performance running back for years. We are interested in having them "connect up" with work that they can handle to the owner's real advantage, and we shall welcome the opportunity to talk definite facts with you.

Write us about your hauling, and we will furnish some decidedly interesting facts about the PLYMOUTH—without obligating you in the least.

### THE J. D. FATE COMPANY

214 Riggs Avenue

PLYMOUTH, OHIO

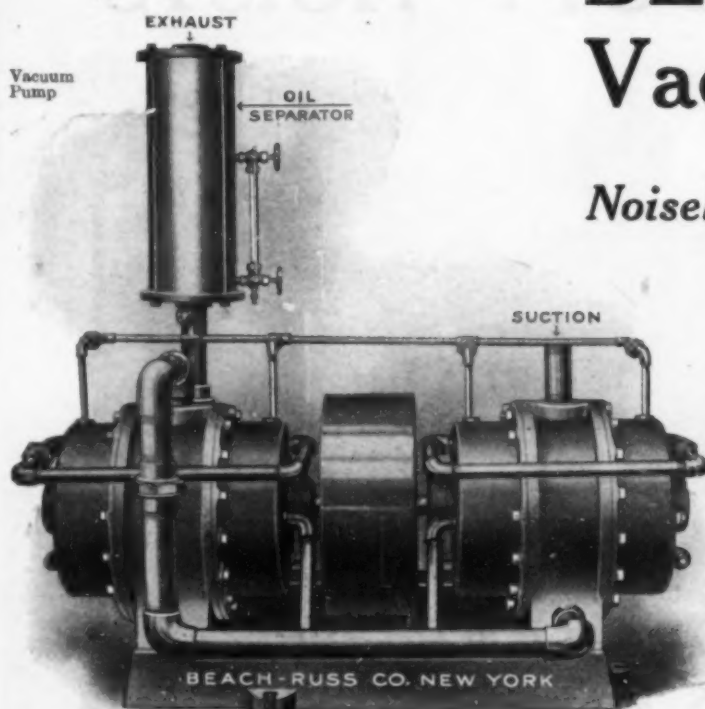
Sales Representatives in all Principal Districts



# BEACH-RUSS Vacuum Pumps

(Patented)

*Noiseless as a Motor  
Simple as a Wheel*



That's why they last indefinitely without repairs. No gears or complicated parts to get out of order or wear noisy and loose. Cost less, wear less, are troubleless. Automatic oiling device does away with oil cups.

Compound High-Vacuum Pumps guaranteed to exhaust to *within 1/10 inch of the barometer*. Single-Stage Vacuum Pumps guaranteed to show 27 in. or more on the mercury column, the barometer being at 30 in.

We also build Acid Pumps, Pressure Blowers, Pulverizing and Grinding Machinery, Filter Presses.

**BEACH-RUSS CO.**

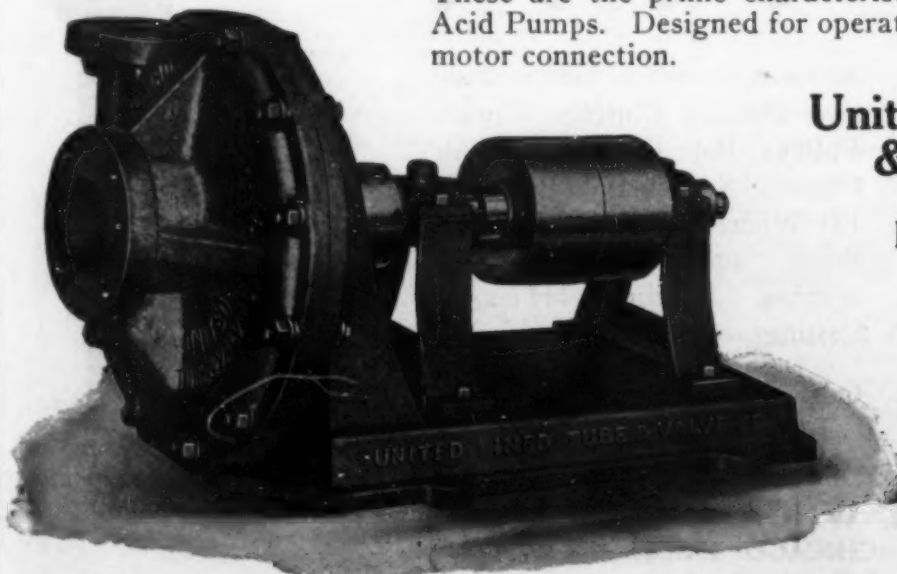
220 Broadway, New York

Works: Brooklyn, N. Y.

# Hard Lead Centrifugal Acid Pumps

**Strength—Service—Durability**

These are the prime characteristics of our Centrifugal Acid Pumps. Designed for operation by pulleys or direct motor connection.



**United Lined Tube  
& Valve Co.,**

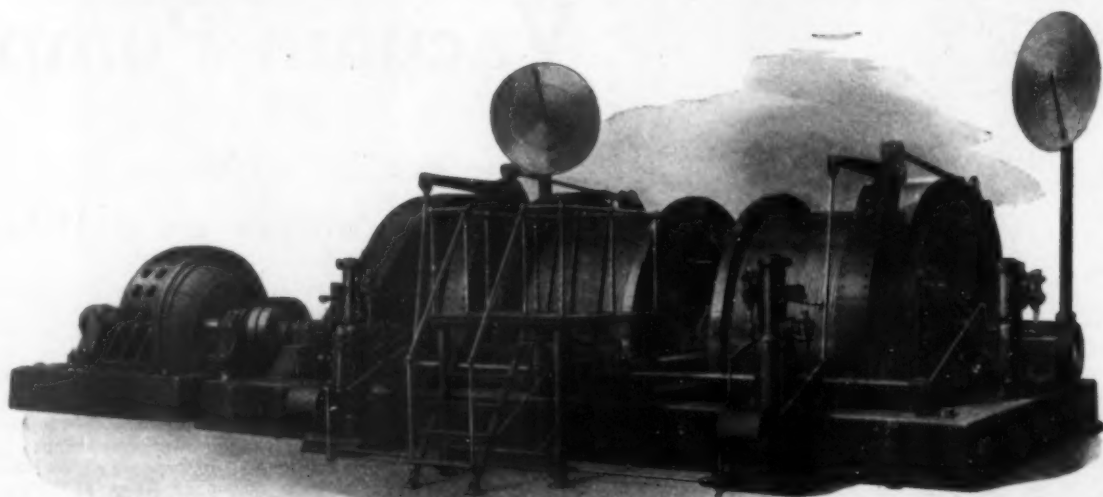
Manufacturers

**Boston, Mass.**

*General Selling Agents:*

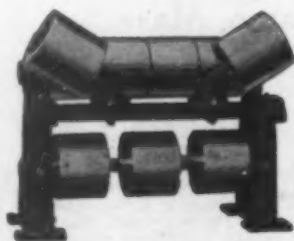
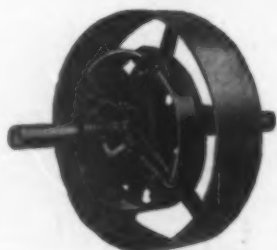
United Lead Co.,  
111 Broadway, New York  
Chadwick-Boston Lead Co.,  
Boston, Mass.  
Raymond Lead Works,  
Chicago, Ill.  
Tatham & Bros. Wks.,  
Philadelphia, Pa.  
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Cleveland, O.  
Canadian Agents:  
Hoyt Metal Co., Toronto

# HEAVY DUTY HOISTS



*Designed and Built by*  
**ALLIS-CHALMERS MANUFACTURING CO.**  
 MILWAUKEE, WISCONSIN

## CALDWELL Conveying, Elevating and Power-Transmitting Machinery



Screw Conveyors, Gears, Pulleys, Friction Clutches, Clutch Pulleys, Belt Conveyors, Link Chain, Sprockets, Bearings, Fly-Wheels, Elevator Buckets, Boots and Steel Casings, Screens, Shafting, Heavy Castings, etc.

Out catalog 38A shows the complete Caldwell line.



**H. W. CALDWELL & SON CO.**

CHICAGO: 17th St. and Western Ave.

DALLAS, TEXAS, 709 Main Street

NEW YORK, 50 Church Street

# LINK-BELT


## SILENT CHAIN DRIVES

### CONSERVE POWER

ADOPT this highly-efficient drive for every service that requires positive, non-slip power transmission. It is flexible as a belt—positive as a gear—more efficient than either.

Link-Belt "Safety-first" casings should be used where flying grit and abrasive dust are in the air. Many power users are adopting them on all drives. For particulars, address nearest office.

**LINK-BELT COMPANY**  
PHILADELPHIA CHICAGO INDIANAPOLIS



## ARE YOU PLANNING TO BUILD?

Save money and time on any extensions or equipment for your

### Chemical and Industrial Plants

by getting in touch with our organization before you place your contracts

### We Design—Construct and Erect

Vacuum Driers and Impregnating Apparatus, Filter Presses, Evaporators, Distilling Apparatus and other equipment. Write now for our bulletins and ask us to quote on your requirements.

**HENRY E. JACOBY**

*Contracting Engineer*

95-97 Liberty St., New York

## PNEUMERCATOR SYSTEM

### A PERPETUAL INVENTORY

of your stocks of acids, oils, liquid fuel, liquid raw materials or goods in process, is furnished by this system.

Operates at atmosphere, pressure or vacuum. Accuracy guaranteed.

**THE PNEUMERCATOR COMPANY, Inc.**  
15 Park Row, New York City

## The Braun Electrolytic Outfit

With Revolving Anodes



### The Most Modern and Efficient Apparatus for Electrolytic Determinations

Electrolytic determinations of copper ores with revolving anodes and gauze cathodes combine accuracy with rapidity. For ores averaging from five to twenty per cent. copper, twenty minutes is the time required for electrolysis. Each additional twenty per cent. of copper value requires ten minutes longer.

The cabinet is constructed so that all exposed parts are made of material resistant to acid fumes. All the other parts are protected by the cabinet.

The Braun Electrolytic Outfit is made in three sizes, having respectively two, four and six units. All the units are operated from a single motor. Units may be operated together or singly, each being independent.

*Circular S-101*

**BRAUN KNECHT-HEIMANN CO.**

**BRAUN CORPORATION**

San Francisco, U. S. A.

Los Angeles, U. S. A.

Manufacturers of Laboratory Labor-Saving Machinery  
Specialists in Laboratory Equipment and Testing Apparatus  
Dealers in Laboratory Glassware and Chemicals



# ever have crusher trouble?

remember the delays, repair bills, annoyance?

Maybe a bolt, a nut or some other piece of tramp iron slipped in. There was nothing to stop it. Just a crash and—you paid the piper.

## DINGS MAGNETIC PULLEY

has a grip like steel. It stops all tramp iron. *All*, mind you, large or small.

Users say "Dings" pays for itself *many times over*.

*Why not investigate it?*

**Dings Magnetic Separator Company**

666 Smith Street  
Milwaukee, Wisconsin



# SPRACO

## PNEUMATIC PAINTING EQUIPMENT

One man does the work of  
3-12 experienced painters

depending on the class of work.

A period of tremendous activity for reconstruction is beginning.

Plants have to be remodeled, new buildings erected, in short the finishing touch is always the "coat of paint."

The economical, quick, the accepted way of painting is the Spraco way—pneumatic—by means of the paint gun. The coating is applied without streaks or brush marks. The extension pole enables the painter to cover surfaces not reached by hand brush—an all-around saving of time, scaffolding and—*labor*.

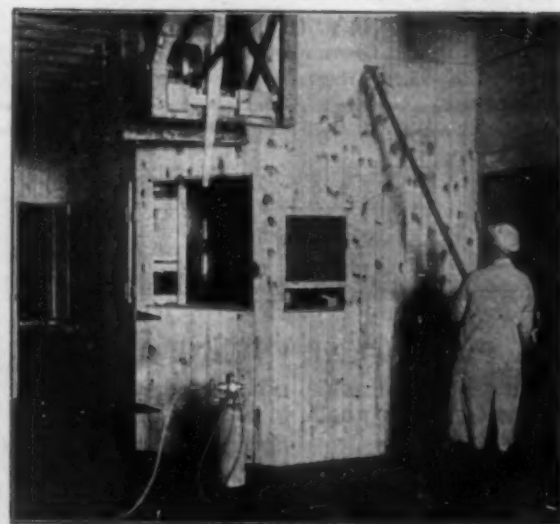
Several sets of interchangeable caps and nose pieces can be used on the gun, making the equipment applicable for handling all kinds of liquid coating.

It is being extensively, almost universally used. Will stand hard service.

It is well to be prepared. Investigate now.

Send for Bulletin on Paint Spraying, and let us know the details of your painting problems.

Spray  
Engineering  
Co.  
Boston, Mass.



# WEBSTER



Elevator and Screen at Quarry.



Handling Boiler Coal and Ashes.

The **WEBSTER M'F'G Company**

Tiffin, Ohio

Chicago

New York

(251)

## Moving Material from Place to Place

Webster Conveyors and other machinery move materials up, down or horizontally. Today they are in demand in every industry.

Because Webster built machinery is dependable, —stays in action, —keeps working without interruption.

We will gladly acquaint you with installations in your field if you will indicate your operations and their extent.

Our aim is to help operators everywhere to these three desirable results—more product, more profit, and less labor.

**Ask for Webster Literature**



**STOKES DRYERS** are good dryers

**T**ell us your drying problems

**O**ld methods superseded

**K**eep labor costs down

**E**asy to operate

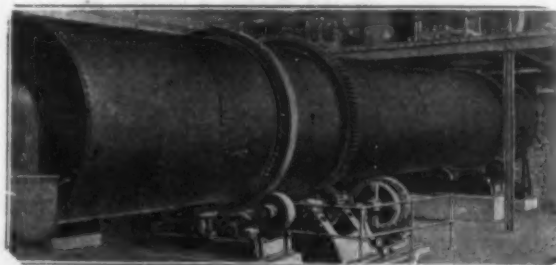
**S**olvents reclaimed

**F. J. Stokes Machine Co.**

Philadelphia

Send for catalog

## This Is



## The Ultimate Cost Dryer

Because of the high percentage of fuel heat utilized and the reduction of labor cost through fast production,

## Ruggles-Coles Dryers

show unexcelled records in economy of operation. They are time-and-money-savers, hence *it pays* to use them.

Made in 7 types and for direct or indirect heat.

**Write for catalogue.**

**Ruggles-Coles Engineering Co.**

50 Church St., New York  
332 S. Michigan Ave., Chicago  
Works: York, Pa.

# Gordon Dryers

## The Principle is Right

Although the general principles that should underlie good drying practice have been long recognized and understood, it remained for the Gordon Dryer to adapt and combine them in a manner to produce

Thorough, Uniform and Rapid Drying within a time that can be absolutely pre-determined.

The Gordon Dryer is designed for results, and built to produce them. It has been so successful that one-half of its entire sales are to satisfied customers.

If you would make a study of your drying problems, start with Catalog 5.

**Gordon Engineering Corp.**

39 Cortlandt St., New York

2010-F



For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.

USE **HYTEMPITE** THE

(Reg. U. S. Pat. Off.)

High Temperature Fire Brick Cement.

**Quigley Furnace Specialties Co.**  
26 Cortlandt Street New York

### NONPAREIL INSULATING BRICK

For Insulating Furnaces, Ovens, Boiler Settings, Blast Mains, Stoves, Kilns

Efficient, Strong, Easy to Apply

**ARMSTRONG CORK & INSULATION CO.**  
156 Twenty-fourth St., Pittsburgh, Pa.

### Clearfield County High Grade Fire Clay REFRACTORIES

Produced by

**CRESCENT REFRACTORIES COMPANY**  
CURWENSVILLE, Clearfield County, Pa.

### "HURRICANE" DRYERS

For

Chemicals, Paints, Colors, Dyes.

Write for full information.  
State material and details.

**The Philadelphia Drying Machinery Co.**  
Stokely Street, above Westmoreland, Philadelphia, Pa.

### DRYERS—CALCINERS

20 Years' Experience Desiccating

COAL, ORES, CONCENTRATES, CLAY, CHEMICAL SALTS, PRECIPITATES AND SIMILAR MATERIALS HAS ENABLED US TO DEVELOP TYPES SUITED TO ANY PURPOSE.

**L. R. CHRISTIE COMPANY**  
307 Fourth Ave., Pittsburgh, Pa.



### Anchor Post Fences

Unclimbable, rustless and fireproof chain link woven steel fences. Unequalled for durability and protection. See our display advertisements in the first issue each month.

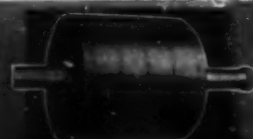
Catalogs or Counsel

**ANCHOR POST IRON WORKS, 167 Broadway, New York**



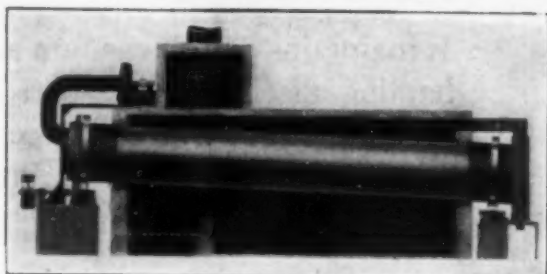
### MAGNETIC SEPARATORS

What they are used for in 35 different industries—explained in Booklet No. 1—CUTLER-HAMMER MFG. CO.





## FOUR FACTORS DETERMINE THE COST OF DRYING



Style D Dryer



Style M Dryer

**THE C. O. BARTLETT & SNOW CO.**  
Main Office and Works: Cleveland, Ohio

The economy of any dryer is determined by four factors. These are:

1. *Fuel Consumption*
2. *Upkeep*
3. *Depreciation*
4. *Interest on Investment.*

It is not always the dryer that has the lowest fuel consumption which is most economical. Frequently the advantage of lower fuel consumption may be more than offset by the disadvantages of higher upkeep, depreciation, and interest charges.

Twenty-six years of broad experience with drying problems have taught us just how these factors affect the cost of drying under different conditions. We are consequently prepared to study individual conditions and shall be glad to tell you which of the thirteen different types of Bartlett and Snow Dryers will give you greatest economy.

*Catalog 16 describes Bartlett and Snow Dryers.*



### Compare Them

The faint light of a candle and the strong rays of a searchlight. They represent the comparative efficiency of other ways of finding what you want and advertising for it in the



613

Employment

SEARCHLIGHT SECTION

Equipment

Business Opportunities

### THE IMPROVED EQUIPMENT CO.

80 Wall Street, New York City

#### COMBUSTION ENGINEERS

DESIGNERS AND BUILDERS OF

COMPLETE GAS PLANTS

LIME BURNING PLANTS

SPECIAL INDUSTRIAL FURNACES

GAS BENCHES

GAS PRODUCERS



W. L. Fleisher & Co. Inc.  
31 Union Square West New York, N.Y.

### Warm Moist Air Dryers



## U. S. SUCTION FILTER

### *Economically Solves the Dust Problem*

It is the most satisfactory means of Collecting Dust or Fumes, for either conservation or sanitary reasons.

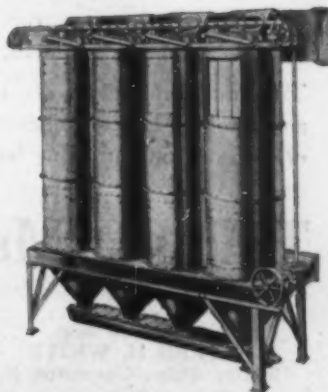
Finely woven bags which are cleaned continuously and automatically, separate the finest solids.

The U. S. is inexpensive both in first cost and operation cost. It is easily installed—adaptable for all plan conditions.

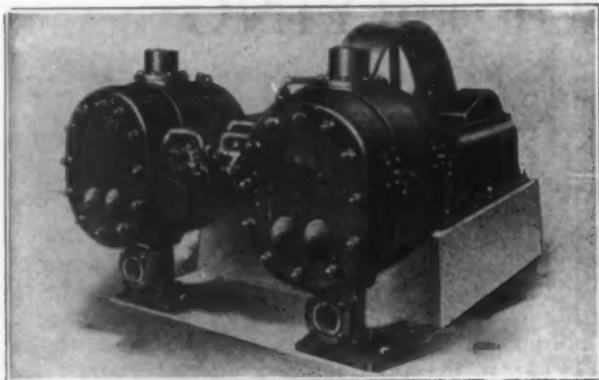
Our engineering department will help you work out the details of an installation.

**U. S. Blow Pipe & Dust Collecting Co.**

216-218 Washtenaw Ave., Chicago, Ill.



## The Ingersoll-Rand Vacuum Pump is Different



"Imperial" Duplex Power Driven Vacuum Pump—  
built steam driven as well

*Ask us to send you  
Bulletins 3037 and 3038.*

### Ingersoll-Rand Co.

11 Broadway New York      Offices the World Over      165 Q. Victoria St. London

For Canada, address Canadian Ingersoll-Rand Co., Montreal.

It maintains a high vacuum and handles discharge pressures of several pounds with a degree of economy heretofore not realized.

All moving parts except the fly wheels are wholly enclosed and automatically lubricated.

This insures long, satisfactory operation. Were this the only feature of superiority it would justify your preference, but there are many others about which we want to tell you.

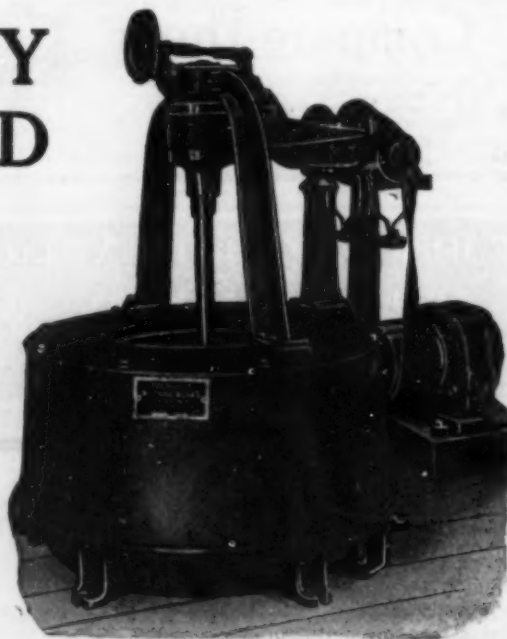
## SCIENTIFICALLY SELF-BALANCED

That expresses it—the word SCIENTIFIC—as it applies to the manner of design and operation of the Self-Balancing feature of

### Tolhurst Centrifugals

This Self-Balancing feature permits safer handling of unbalanced loads at high speed. Gravity is the controlling factor—no springs, rubber cushions or other complicated devices being employed.

Tolhurst Centrifugals are unapproached for continuous and exacting service. They are recognized as the standard of efficiency and durability for all classes of chemical work.



## Tolhurst Machine Works, <sup>Established 1852</sup> Troy, N. Y.

New York Office: 111 Broadway

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**FRED H. WHITE**  
Realty Bldg., Charlotte, N. C.

Canadian Rep.  
**W. J. WESTAWAY**  
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Western Rep.  
**JOHN S. GAGE**  
Hartford Bldg., Chicago, Ill.



## EXPANDING

As all our time is taken up with the manufacture of Custom Made Transformers for the

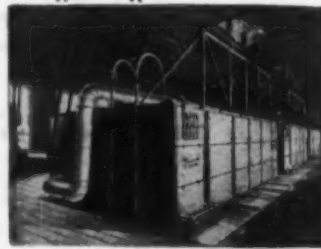
U.S. Government we were forced to expand our facilities and we shall soon be in the position to take care of such work as is essential in the successful prosecution of the war.



40 Kva., 100,000 volt transformer for Central System of Precipitation.

**The American Transformer Co.**

Office and Works:  
151 Miller Street  
Newark, N. J.



INSTALLATION OF THREE "PROCTOR" DRYERS FOR CHEMICALS

## WHY TO CONSULT A DRYER EXPERT

The artificial drying of materials may be simple in theory, but

it is often complicated in practice. During 35 years we have developed dozens of special drying machines, and have discovered hundreds of facts which it is necessary to know and apply in order to handle successfully such materials as paint colors, chemicals, dry colors for printers' ink, aniline dyes, lithopone, white lead, glue, fabrics, ceramic ware, raw stocks, rubber, copra, etc., etc.

We have a skilled engineering staff, including traveling engineers and an experimental department, all of which are at your service for the solution of your drying problems.

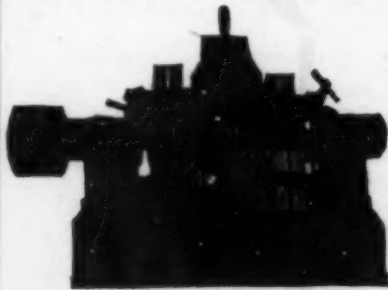
State conditions fully.

**Proctor**  
DRYERS

THE  
PHILADELPHIA  
TEXTILE MACHINERY CO.  
PHILADELPHIA, PA.

8

## Low Voltage Generators



Up to 10,000  
amperes

Single, two and three voltages for School and Laboratory work. Deposition, Refining and Separation of metals.

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513-515 West 29th St., New York

## BRADY

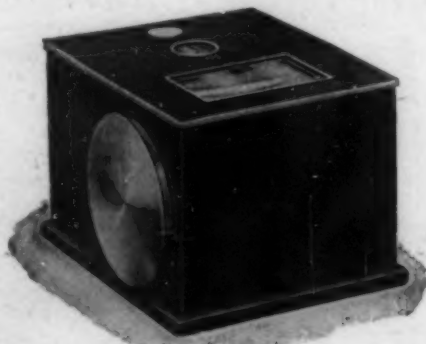
### CHEMICAL CASTINGS

We have facilities for handling all kinds of castings for chemical purposes up to 35 tons each. Any kind of metal always available.

*Write for particulars.*

**James A. Brady Foundry Co.**

43th Street and Western Boulevard  
Chicago



## You Must Use a Good Pyrometer If You Wish Good Results

If you expect continuous operation without annoying delays, if you wish to establish a reputation of uniformity for your product, buy a dependable pyrometer and be free from worries.

The Engelhard Le Chatelier Pyrometers are backed up by records of years of satisfactory service in the plants of prominent manufacturers.

**CHARLES ENGELHARD**

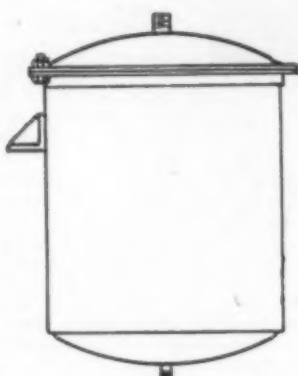
30 Church Street

NEW YORK

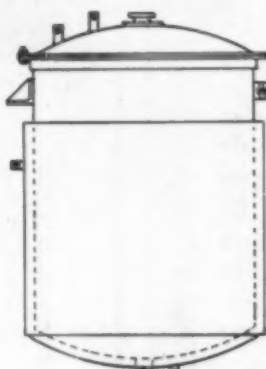


# FOR PROMPT SHIPMENT

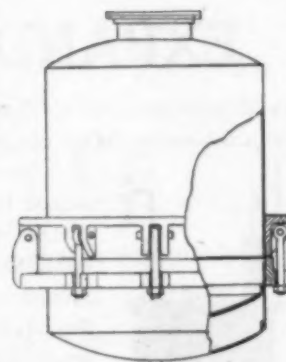
*Within a Week Subject to Prior Sale*



Pressure Tank  
Capacity 450 Gal.



Jacketed Tank  
Capacity 500 Gal.



Filter  
Capacity 400 Gal. as a Tank

*Can be made to conform to customers' requirements*

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Telephones—Barclay 4864-4865

## Uniform Product and Accurate Determinations Made Possible by Carrier System

In the chemical plant especially proper atmospheric conditions are an important factor, and in many processes and determinations, good work is impossible unless humidity is maintained constant.

A Carrier System not only automatically humidifies or dehumidifies so as to keep the percentage of humidity constant, but it goes even further. It regulates the temperature giving heating in winter and cooling in summer—If desired absolutely constant humidity and temperature can be secured all the year 'round.

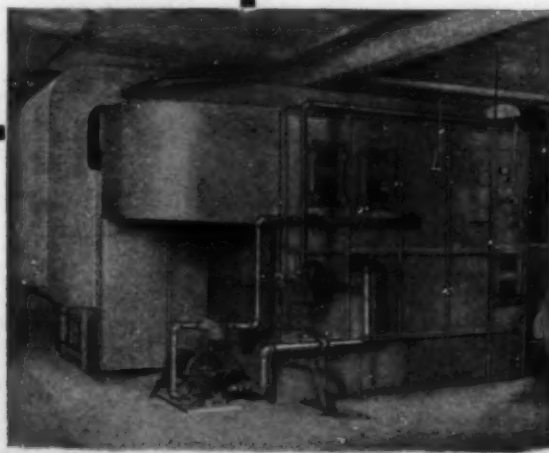
By no means the least of the advantages of the Carrier System is its ventilating feature. All fumes, odors, impure air and fine dust are removed by the exhaust fans and entering air is purified and washed before being distributed to the various parts of the building.

Our Engineers will tell you exactly how a Carrier System will humidify, dehumidify, cool, heat, ventilate, give healthy working conditions, reduce labor unrest and how long it will take to pay for itself. Why not let one of them visit you—or if not that, send for our bulletin.

## Carrier Engineering Corporation

39 Cortlandt St., New York

Boston, Philadelphia  
Buffalo, Chicago



## We have made LEAD LINED IRON PIPE over Twenty Years

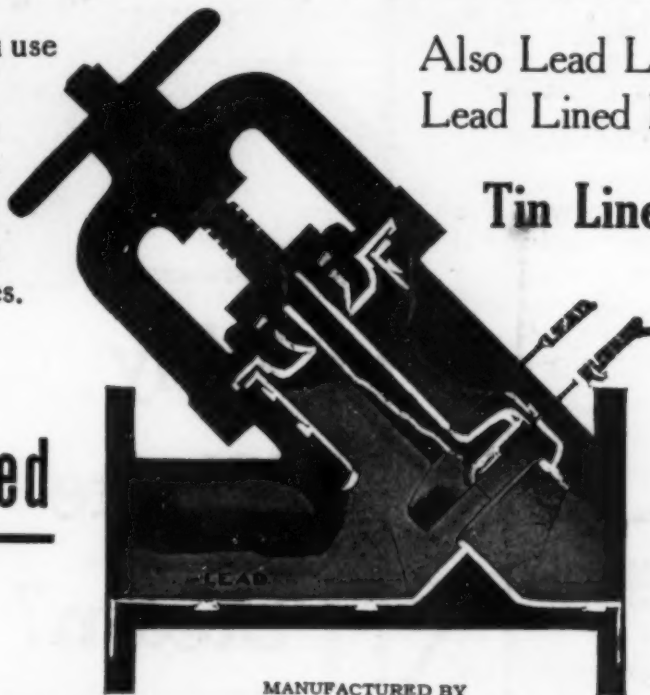
Be sure that you use  
"Amalgamated"  
Lead Lined Iron  
Pipe—We are  
the only makers  
of that pipe in  
the United States.

Also Lead Lined Iron Valves  
Lead Lined Iron Stop Cocks  
AND

**Tin Lined Iron Pipe**

**Lead Lined**

**Iron Valve**



MANUFACTURED BY

**LEAD LINED IRON PIPE CO. Wakefield, Mass.**

## Kestner Evaporators

*Simple Economical Efficient*

**Resines  
Super-Filters**

*No Choking  
No Cloths To Wear Out*

## Our Chemical Laboratory

is well equipped to  
help you with your  
*Process Problems.*

**Kestner Evaporator Company**  
Paris Philadelphia London

## CROWELL

**Air Compressors and  
Vacuum Pumps  
Positive Pressure  
Blowers**

**Crowell  
Manufacturing  
Co.**

290 Taaffe Place  
Brooklyn, N. Y.



**ROOTS**

**BLOWERS &  
GAS PUMPS**

See our half-page advertisement in the next issue.  
P. H. & F. M. ROOTS CO., Connersville, Ind.  
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## Heavy Plate Fabrication

Dryers, Digesters, Cookers, Chemical Tanks, Welded  
Vessels, Galvanizing Kettles, Autoclaves, Mixers, In-  
cinerators, Retorts, etc.

**Manitowoc Engineering Works**  
Manitowoc, Wisconsin

## Sil-O-Cel Saved Fuel on War Work—it Will Increase Peace- Time Production

Through actual coal shortage and the desire to cooperate with the fuel administration, industrial concerns have learned that they could operate at full capacity with less coal by preventing heat losses with Sil-O-Cel. Now, to secure increased production, — under competitive conditions, Sil-O-Cel will mean a real economy to you.



Sil-O-Cel is produced from the mineral Celite which has an unusually high insulating value and is unaffected by temperatures which completely destroy other forms of insulation. Weighs only  $1\frac{3}{4}$  pounds per full size brick—has an insulating value 10-times its thickness of fire-brick and has a crushing strength of over 400 pounds per square inch. Put up in brick, powder and cement form to meet all insulating requirements.

Our engineering department will gladly show you how you can increase your production by the use of Sil-O-Cel.

## CELITE PRODUCTS COMPANY

NEW YORK: 11 Broadway  
LOS ANGELES: Van Nuys Building  
PITTSBURGH: Oliver Building  
SAN FRANCISCO: Monodnock Building  
CHICAGO: Monodnock Building

## Why Waste Steam?



If steam was cheap and there were no SARCOS to be had the waste of the first could be tolerated. But steam costs more today than ever before — hence the need for the positive-acting SARCOS.

Smaller in size and far lower in cost, yet fully as efficient as the best float or bucket trap made—that's the SARCOS. A heavy hydrocarbon oil is the acting agent on this trap's one moving part; it won't leak and it never sticks. Over a million of the type in use today. You, too, need them.

Particulars of our trial offer on request.

**SARCOS COMPANY, Inc.**  
Woolworth Building, New York City

Ellicott Square, Buffalo  
Drexel Bldg., Philadelphia  
and representatives in all principal cities  
Canada, Peacock Brothers, Montreal





## Glazed Vitreous Evaporating Dishes

In Stock for Immediate Shipment

We have complete stocks of our entire line of glazed evaporating dishes listed below:

Catalog Number	Approximate Capacity	Internal Diameter	Price Per Dozen
B. 1	25 cc	2 in.	\$15.00
B. 3	45 cc	2 3/4 in.	17.25
B. 5	80 cc	3 1/4 in.	18.75
B. 7	90 cc	3 1/2 in.	20.25
B. 9	100 cc	3 3/4 in.	24.00
B. 10	200 cc	4 1/4 in.	27.75

These prices (which include the recent advance of 25%) are net F. O. B. our Brooklyn, N. Y., warehouse, transportation charges prepaid (routing at our option) on orders amounting to \$25.00 or over.



Unbreakable with temperature changes.

Constant in weight.

Homogeneous. Highly resistant to reagents.

THE THERMAL SYNDICATE, LTD  
CHEMISTS' BLDG. 50 E. 41<sup>st</sup> STREET  
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## Recovering Trade Wastes

### Results Guaranteed

in connection with Pulp, Paper, Cotton-Mercerizing, Glycerine, Sugar, Coke-oven and Coal-tar products, Benzol, Toluene, etc., etc.

### Evaporation

Largest Builders of Evaporating Machinery.

### Distillation

Water, Oils, Solvents, Glycerine, etc.

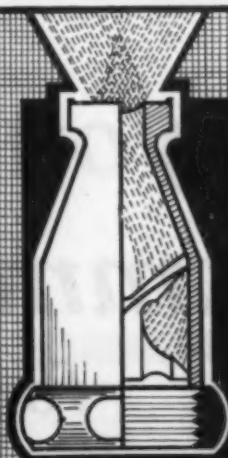
## CHEMICAL APPARATUS

designed and furnished for all purposes. We superintend erection, instruct operators and guarantee correct working.

## Ernest Scott & Company Engineers

Business Founded in 1834

Fall River, Mass.



### "SPRA-RITE"

Low-Pressure Nozzles Are Preferred by Hundreds of Power, Industrial and Chemical Plants for Cooling Condensing Water, Gas Washing and numerous uses where large capacity and low operating pressure are necessary.

Write for complete descriptive literature of our patented "SPRA-RITE" Nozzles for all purposes.

We specialize in Spray Nozzles for all requirements—also fine spray producers for Sulphuric Acid, Lead Chambers, made of Stoneware, Hard Lead, Monel Metal and other Acid-resisting Materials.

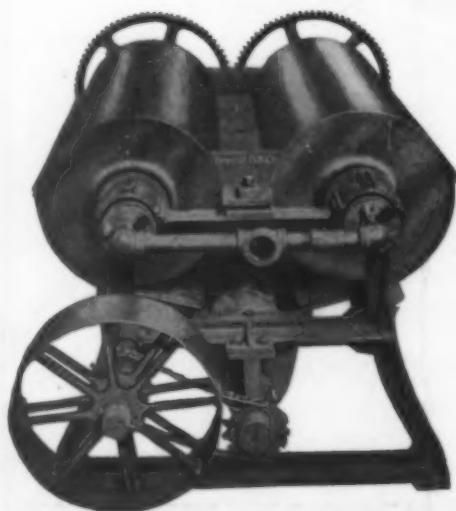
**"SPRARITE"**

THE STAR  
BRASS WORKS  
3116 Carroll Ave.  
CHICAGO

# CHEMICAL COOLING

For Cooling and Flaking Chemicals Use

## Brecht Patented Duplex Cooling Cylinder



A constantly revolving large cooling surface.  
Capacities from 1000 to 8000 pounds per hour, depending upon temperature of material.

Cooling agent may be either Water, Brine or the Direct Expansion of Ammonia in conjunction with Mechanical Refrigeration.

### The Brecht Refrigerating Machines

may assist you further in solving your cooling problems.

We also manufacture

Cotton Seed Oil and Vegetable Oil Refining Plants—  
Deodorizers—Compound Lard Plants—Evaporators—Filter  
Presses—Rendering Tanks and Fertilizer Dryers.

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ESTABLISHED 1853

Exclusive manufacturers of machinery, equipment, tools  
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## Save your Ammonia for the Government

Recovery and  
Concentrative Apparatus

ISELL-PORTER COMPANY, NEWARK, N. J.

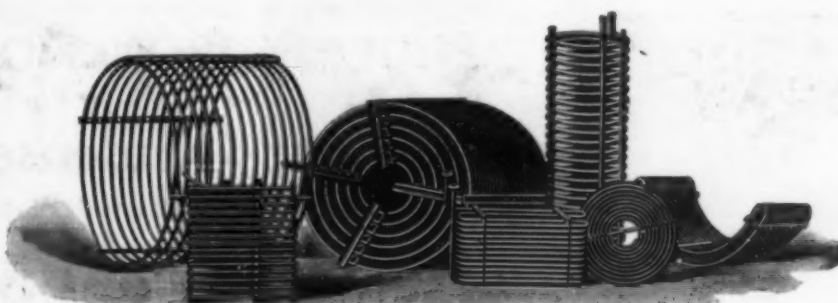
## Coils and Bends

—of all kinds are our specialty.

Made of copper, brass, iron or steel pipe or tubing. For heating, cooling, refrigerating or any other purpose.

We carry a large stock of copper tubing of various sizes and gauges and extra heavy wrought iron and steel coiling pipe, so that we can make prompt shipment.

Estimates furnished promptly. Let us figure on your requirements



**THE WHITLOCK COIL PIPE CO., Hartford, Conn.**

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## Piping Systems

We design, manufacture and install complete Piping Systems for all purposes.

Piping Systems for Chemical Plants and Power Plants, a specialty.

**The M. W. Kellogg Company**  
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## LARGE HARD LEAD CASTINGS

Large Hard Lead Castings up to ten tons in weight, better lead castings than were ever imported.

According to your specifications, and delivered when you say.

**CRAIG FOUNDRY COMPANY**  
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## Large Chemical Equipment of Copper

*Autoclaves  
Evaporators*

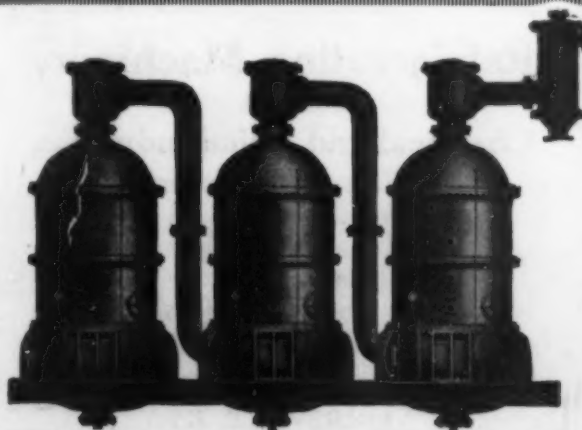
*Extractors  
Still, Etc.*

**GEORGE F. OTT CO.**

Coppersmiths, Tankmakers, Machinists

Office: 213 Buttonwood St., Phila., Pa.

Est. 1870 in Phila.







## PHOENIX IRON WORKS CO.

MEADVILLE, PA.

### Barometric Condensers—Tanks

Riveted and Welded Plate Work

### Iron Castings—Special Machinery

Philadelphia

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Sales Offices:

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## REDMANOL

*The material of a thousand uses*

### Perfect Electrical Insulation

made from

The Anhydrous Phenol Resin Compounds

They excel in

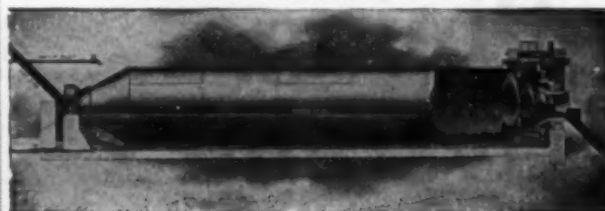
HEAT RESISTANCE—DIELECTRIC  
STRENGTH—MECHANICAL STRENGTH—  
ACCURACY OF DIMENSIONS

Write for catalog

Redmanol Chemical Products Co.  
656 West 22nd Street, CHICAGO

## THE BAKER COOLER

Applicable to metallurgical and industrial calcines  
Saves Power, Water, Dust and Headroom



Recent orders received:  
The Norton Company (repeat) Empire Zinc Co. (repeat)  
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THE STEARNS-ROGER MFG. CO.  
Denver, Colo.

## "CENCO"



### "CENCO" BALANCES AND WEIGHTS

"Cenco" Analytical and Torsional Balances and Weights are sold under careful specifications regarding their degree of accuracy and sensibility; and the specifications as stated are guaranteed correct. This policy of Buyer Protection is a part of "Cenco" Service.

Bulletin and prices upon request. Stock deliveries!

Central Scientific Company  
460 E. Ohio St., Chicago, Ill.

THE HOUSE OF SERVICE



*Centrifugals*  
We specialize on single stage low head centrifugal pumps.  
Ask for Catalog  
TABER PUMP COMPANY  
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## FLETCHER WORKS

The Fletcher Works laboratory centrifugal meets all the varied requirements of the laboratory chemist. Simple, safe, durable, convenient, easy to operate, efficient.

## FLETCHER WORKS

formerly Schaum & Uhlinger,

Glenwood Ave. and Second St., Philadelphia, U. S. A.

## Refrigerating Machinery

for the

### Chemical and Allied Industries

Water Tube Boilers

Drop Forged Valves and Fittings

"Sectional" Rocking and

Dumping Grates

"Sectional" Steel Casings

for Boilers

HENRY VOGT MACHINE CO.  
LOUISVILLE, KY.

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Antimony Magnesium  
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## SPECIALTIES

Palladium Thorium  
Tungsten Titanium  
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### Foote Mineral Company

Established over 40 Years.

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Our bulletin describes the successful solution of many materials-handling problems. Let them help you.

### ROBINS CONVEYING BELT COMPANY

New York, 22 Park Row Chicago, Old Colony Building  
Salt Lake City, Newhouse Building  
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## Monel Metal Centrifugal and Filter Cloth

Fine meshes of wire cloth, in either Monel Metal or Copper, particularly centrifugal and filter cloth, are now available.

**B & G**  
WIRE  
PRODUCTS

include cloths, fine or coarse, light or heavy, for every purpose where accuracy is required. Let us send you samples and prices.



**Supplee-Biddle Hardware Co.**

513 Commerce St.  
Philadelphia

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## WHATMAN *High Grade* FILTER PAPERS

—*the*  
**Universal  
Standard**

for all analytical  
purposes.

Stocks carried by all recognized dealers in Laboratory Supplies. If any difficulty in obtaining your Whatman requirements, please advise.

**H. REEVE ANGEL & CO.**

Incorporated

7-11 Spruce St., New York

*Sole Representatives  
for North America*





**The Raymond W. Dull Labor-Saving Equipment**

We are engineers with specialized experience in designing conveying and elevating machinery for every kind of bulk material.

We are especially equipped to plan and equip the system that will most efficiently care for your operation.

**DULL CONICAL SCREENS**  
Are the result of years of research and experience. They provide economical solution of your screening and washing problems.

*Our engineers gladly extend their services.*

**The Raymond W. Dull Company**  
1910 Conway Bldg., Chicago.



**THAT Filter Cloth—  
MONEL METAL**

practically NEVER wears out!

No Attention—  
No Replacement—  
It cuts Labor Costs!

Are you using cotton or camels' hair filter cloths when you could use MONEL METAL? Then you are paying too much for your filtration results. For THIS closely woven cloth, strong, acid- and alkali-proof and practically everlasting, will do the work better at lowest labor costs. This is a scientific product—it deserves your investigation if you are interested in worth-while economy.

*Prompt Delivery.  
Let us cover your filter leaves.*

**MULTI-METAL CO., INC.**  
Makers of Screens from 4 to 350 Mesh, in all Metals  
254 West 19th Street, New York City

**MONEL METAL**  
is Acid-Proof and  
Alkali-Proof





# NEWARK WIRE CLOTH

## *America's Standard*

**Brass—Copper—Monel Metal  
Phosphor-Bronze  
Pure Nickel**

Newark Wire Cloth is made by experts using the latest type of automatic machines. It can be rapidly cleaned, and is *accurate as to weave and standards.*

Extra fine Phosphor-Bronze Wire Cloth, all meshes, Plain and Twilled Weave.

Newark Filter Cloth (Patented) for all pressure filtration, has double Filtration Surface, is extra strong, rapidly cleansed, made of monel metal. Samples on request.

*Write for Complete List of  
Products.*

**Newark Wire Cloth Company**

*Wire Cloth in All Metals—Filter Cloth, etc.*

**222-228 Verona Ave., Newark, N. J.**



Iron Recased Plate Press

### FILTER PRESSES

We build all sizes and styles from 12 inch to 40 inch.

For all liquids which require filtering, or separating solids held in suspension and forming into cakes

Acids, Chemicals, Colors, Dyes, Oils, Paints, Varnish, Glue, Glucose, Starch, Lard, Syrup, Yeast, Glycerine, Liquid Soap, Lyes, Tallow, etc.

Write for Information and Prices

**WILLIAM R. PERRIN & COMPANY**

Old Colony Building

2

CHICAGO, ILLINOIS

### BONE BLACK FILTERING PLANTS

KILNS and FILTERS

for

**Bone Black and Fullers Earth**

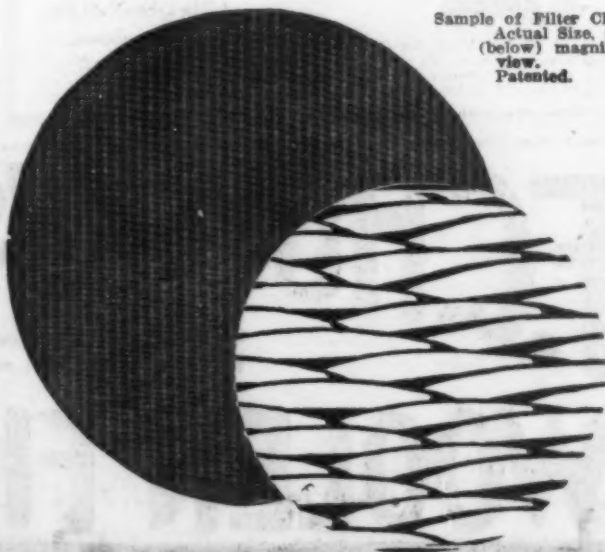
Any Capacity

Your problem handled to your satisfaction

**LEWIS COLWELL**

1817 CONWAY BUILDING, CHICAGO

Sample of Filter Cloth  
Actual Size, and  
(below) magnified  
view.  
Patented.



## WOOD, PLATE and FRAME FILTER PRESSES

All Standard Sizes in Stock  
Just Patented (No. 1,282,414)

Our IMPROVED Movable Field Wood  
Filter Press Plate

has rigid outer frame; high washing type feeds  
quicker and more uniformly; saves filter cloths,  
and labor.

*We will cheerfully send them on approval.*

**Independent Filter Press Co., Inc.**

418 Third Avenue, Brooklyn, New York

Phone South 5162

## Centrifugal Linings and Filter Press Plates

Steel, Copper, Brass, Aluminum, Lead, Zinc,  
Tin and other metals or materials  
perforated as required.

Perforated Metals of Every Description

*Our catalog sent you on request*

**Chas. Mundt & Sons**

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Jersey City, N. J.



## Headquarters for Hydraulic Machinery

We build everything necessary for complete hydraulic installations,—presses, pumps, accumulators, intensifiers, valves, pipe, fittings, etc. Also any special types of presses for every description of high pressure purpose.

Our line of over 5000 complete hydraulic machines offers an extensive selection from standard types. Consult us—no obligation.

**THE HYDRAULIC PRESS MFG. CO.**

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## "Scientia" Calorimeters

and other High-Grade

Physical and Chemical Apparatus

Universal Laboratory Supports—Spectroscopes—Spectrometers—  
Calorimeters—High-Grade Thermometers—Balances—Weights,  
etc. Let us know your requirements and we will send catalogue.

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## Water Filters & Water Softeners

*For the purification of water*

Send for booklet

**HUNGERFORD & TERRY, INC.**

Engineers and Mfrs. of Water Filters Pennsylvania Bldg., Philadelphia

## FILTER PRESSES

We manufacture a complete line of filter presses for use  
in chemical, electro-chemical works and the glue, ink,  
paint, oil, battery, carbon, graphite, paper, powder, rubber,  
salt, soap, sugar and dye and color industries.



Special presses  
built with wood  
plates and frames,  
also of bronze and  
other acid and alkali-  
resisting metals.

**The  
Allbright-Nell Co.**

Manufacturers

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A Perfect Press for General Work  
Made in four sizes—18 in., 24 in., 30 in., 36  
in. square. Recessed Plates. Center Feed.  
Open Delivery.

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## Direct Flow Filtering and washing with the chemical type of press

**ALFRED BURGER & CO.**

Filter Press Engineers

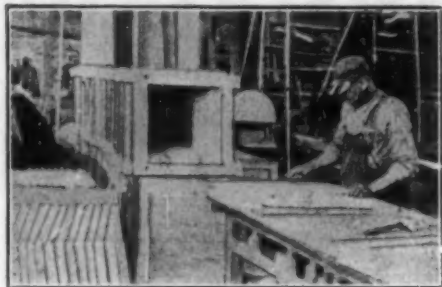
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**F.C. HUYCK & SONS** Kenwood Mills  
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Our forty-five years of experience in the manufacture of the  
finest mechanical woolen cloth guarantees you satisfaction.

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## SPERRY FILTER PRESSES GIVE SATISFACTION



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## Practice Makes for Perfection

Undeniable this. Our men have spent a lifetime making and improving Filter Presses. The result of 30 years' conscientious and painstaking efforts, guided by expert engineering advice are the Sperry Filter Presses.

They have exclusive feature characteristic *only* of the

"Sperry" which makes them the national, sensible and accepted Filter Presses for Problems where highest efficiency, economy and lasting qualities are desired.

They are made in several sizes to meet varying requirements. Catalog on request.

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New York Agent: H. E. Jacoby, 95 Liberty St.

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WE ARE MANUFACTURERS  
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*First Source of Supply*

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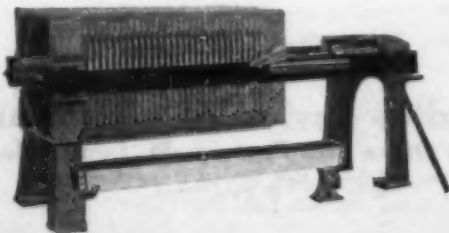
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ANGLES CHANNELS

MADE IN

SILVER, ALUMINUM, NICKEL SILVER,  
PHOSPHOR BRONZE AND ZINC

### For Immediate Delivery

The following latest models of  
"JOHNSON" Filter Presses  
All New Machines



2—30-in. square, side feed, open delivery, washing, cast iron Filter Presses, flush plate and distance frame pattern with 48, 36, 24 or 18 chambers, with 1 1/2-in. or 1-in. distance frames.

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1—24-in. square, corner feed, draining, closed delivery, cast iron Filter Press, flush plate and distance frame pattern with 36, 30, 24 or 18 chambers with 1-in. distance frames.

2—24-in. square, center feed, open delivery, washing, cast iron Filter Presses, recessed pattern with 36, 24, 18 or 12 chambers, making cakes 1 1/2-in. or 1-in. thick.

1—24-in. square, center feed, open delivery, cast iron Filter Press, recessed pattern with 48, 36, 24, 18 or 12 chambers, making cakes 1 1/2-in. or 1-in. thick.

1—18-in. square, corner feed, open delivery, washing, cast iron Filter Press, flush plate and distance frame pattern with 24, 18, 12 or 6 chambers, with 1 1/2-in. or 1-in. distance frames.

1—18-in. square, center feed, open delivery, cast iron Filter Press, recessed pattern with 24, 18, 12 or 6 chambers, making cakes 1-in. thick.

1—18-in. square, corner feed, closed delivery, washing, cast iron Filter Press, flush plate and distance frame pattern with 24, 18, 12 or 6 chambers, with 1 1/2-in. or 1-in. distance frames.

1—12-in. square, center feed, open delivery, cast iron Filter Press, flush plate and distance frame pattern, with 18, 12 or 6 chambers, with 1-in. distance frames.

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2-in. x 4-in. and 3-in. x 4-in. single plunger, Pumps, hand, belt or electrically driven, cast iron.

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18-in., 27-in. and 42-in. cast iron Turbine Mixers

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**For Acids and Dyes  
Albany Wool Filter Cloth  
is the logical thing to use**

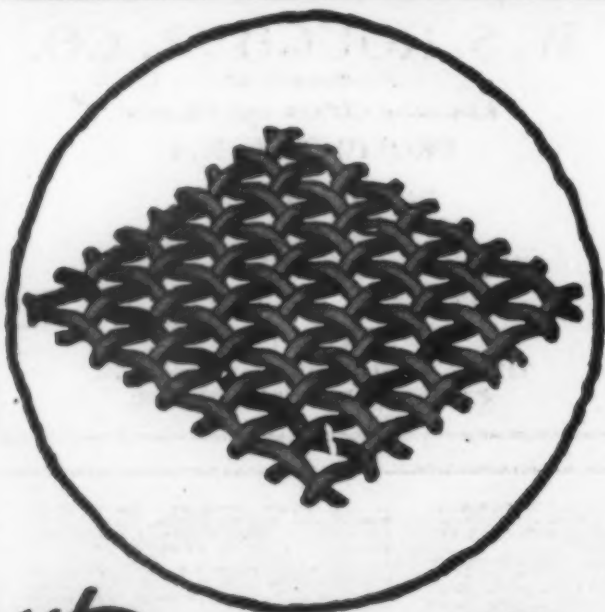


It is a well known fact that wool resists impregnation.

One need only to visualize a hair magnified a hundred times to be thoroughly impressed by this fact.

Wool is stronger than cotton, consequently Albany Wool Filter Cloth not only serves *all the purposes* of the best Filter Cloth, but is cheaper by far, in the end.

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**Double Crimp Wire Cloth**

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Now, more than ever before, the inherent qualities of "Perfect" Double Crimp Wire Cloth are appreciated for all kinds of industrial screening. Increased volume, due to great percentage of open area; uniformity, due to the unchanging mesh; and long service due to even wear and uniform distribution of strains, make "Perfect" screens not only economical but really essential.

*We are able to fill many rush orders for standard screens out of stock, and our facilities for filling special orders, regardless of size, insure prompt service always. Get the habit of depending on us when you need screens quickly. Telegrams get quick action here.*

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We are engineers and contractors for the erection of complete sulphuric acid plants using either the Tower or the Chambers system.

Service is our motto and our prices are attractive.

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Acipruf Cement for all kinds of acids

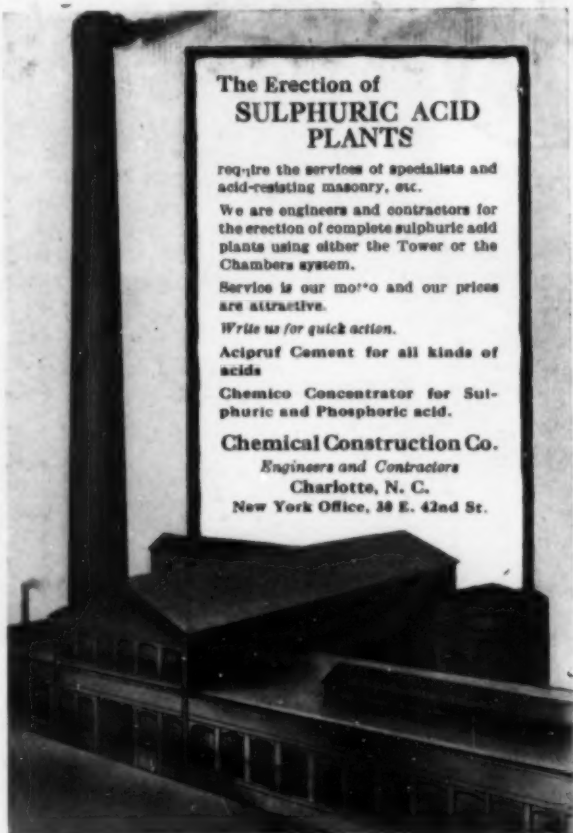
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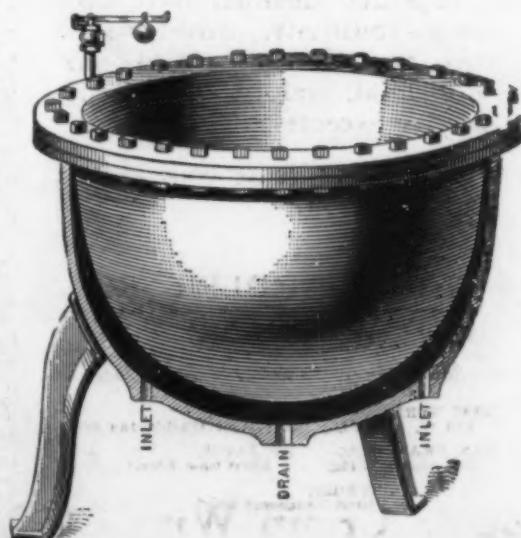
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Do not infer by this that workmanship, material or finish is slighted in the least degree, but during

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When you transfer from test-tube lots to ton lots, your laboratory conditions of resistivity and non-contamination will be retained.

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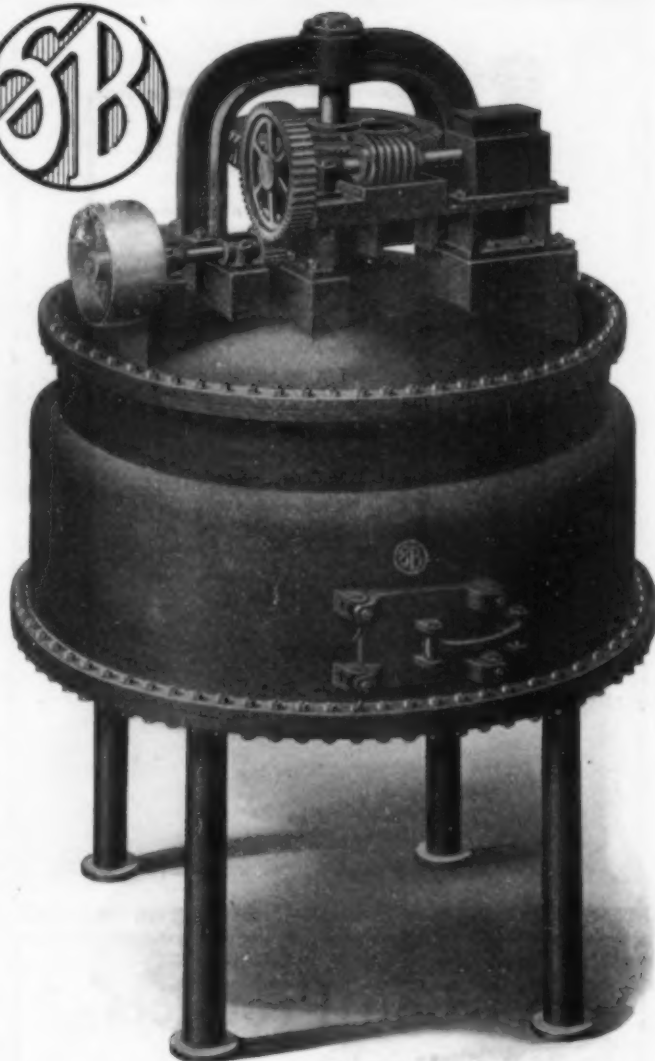
Pfaudler Enamels have unusual resistivity, density and tenacity. They are fused into substantial, welded steel shells and are exceptionally durable.

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STYLE D AGITATOR  
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Unusual facilities for furnishing special Acid Resisting Valves for all chemical manufacturing purposes.

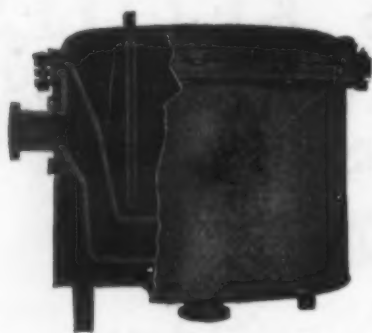
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Chemical Plant Supplies of All Descriptions  
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In this Condenser we have first of all met the requirements for severe acid conditions, whereby vapors or liquids cannot come in contact with anything but acid-resisting enamel, and second, we have devised an apparatus that will effect the *greatest economy in floor space*.

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*Nothing too  
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#### CANTONMENT CONSTRUCTION

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**WILL THE PROPOSED LAKE ERIE & OHIO RIVER CANAL,  
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By W. G. Wilkins, W. G. Wilkins Co., Pittsburgh, Pa.

### THE APRIL ISSUE WILL CONTAIN: ELECTRICITY AS A SUBSTITUTE FOR NATURAL GAS FOR HEATING PURPOSES

Frank Thornton, Jr., Heating Engineer  
Westinghouse E. & M. Co., East Pittsburgh, Pa.

#### MONONGAHELA RIVER NAVIGATION

Lieut.-Col. H. W. Sticks, U. S. Army, Retired,  
District Engineer, Pittsburgh District, Pittsburgh.

### THE MAY ISSUE WILL CONTAIN: SIMPLIFICATION OF RIVETED JOINT DESIGN

By H. A. S. Howarth, Associate.

Albert Kingsbury, Consulting Engineer, Pittsburgh.

**PRODUCE GAS, ITS MANUFACTURE AND USE**  
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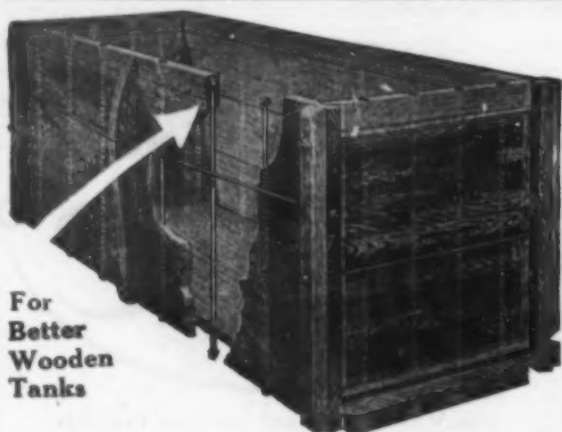
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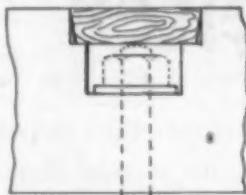




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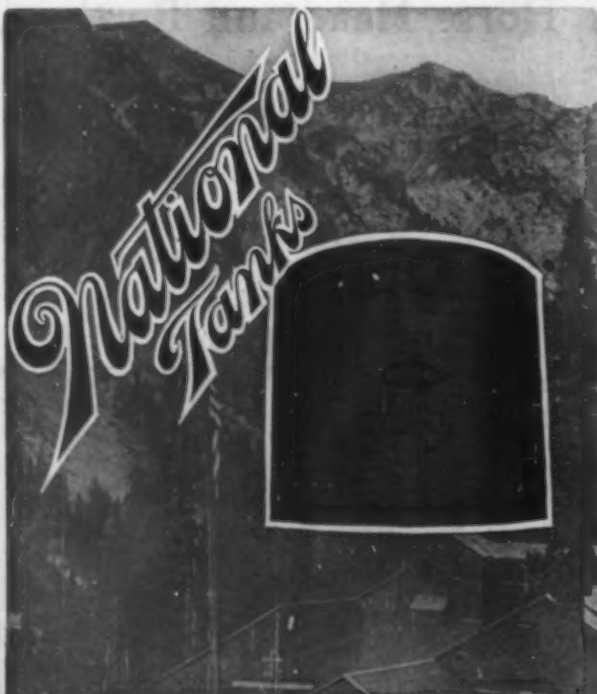
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**Tanks of all Sizes  
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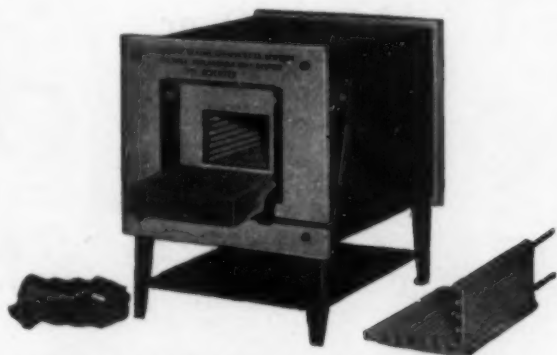
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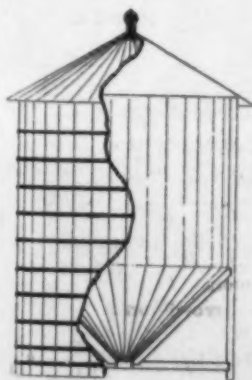
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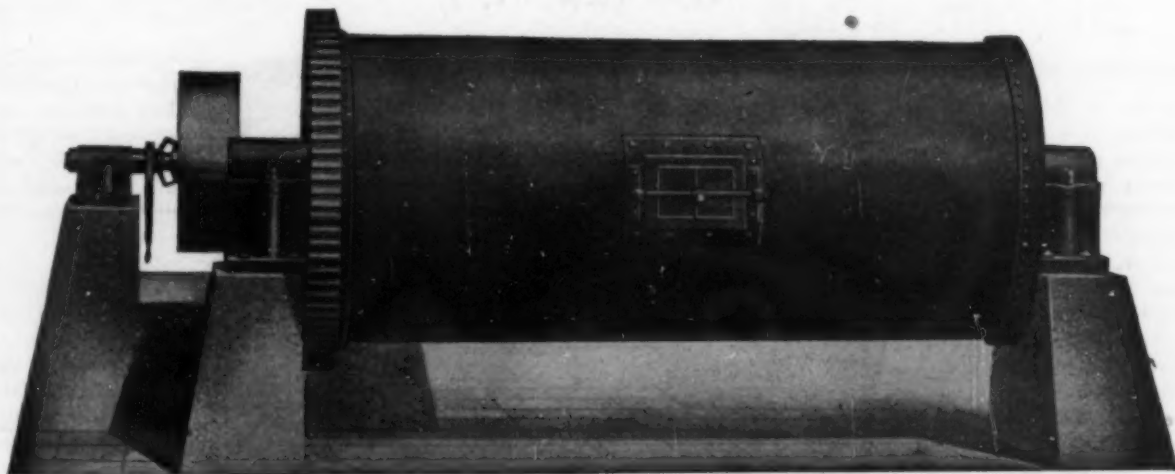
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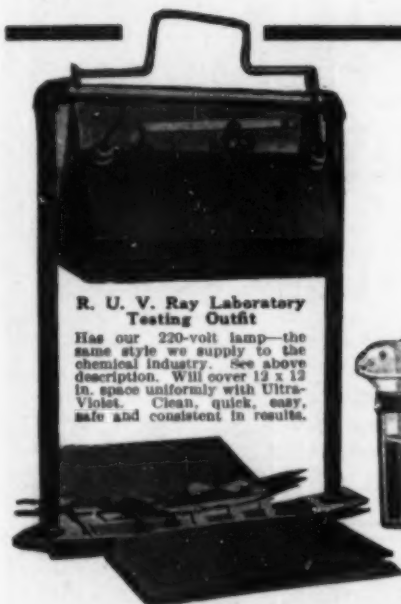
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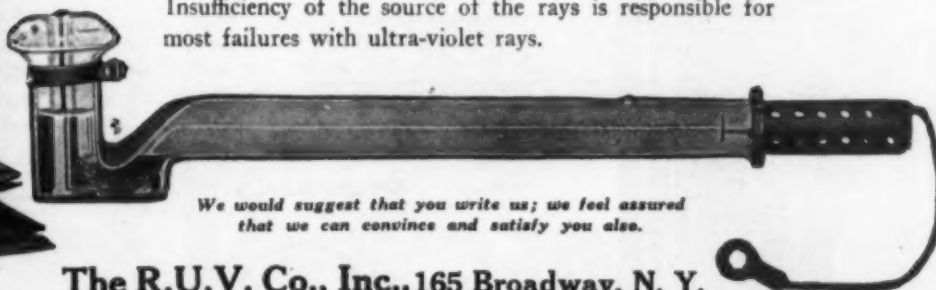
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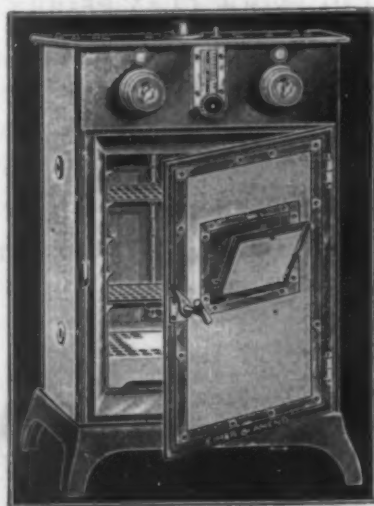
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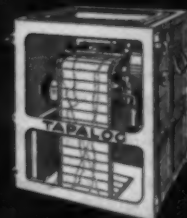
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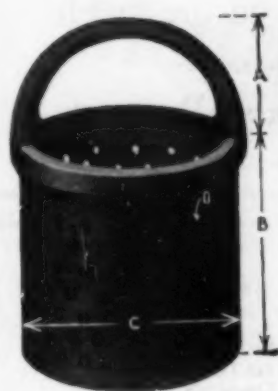


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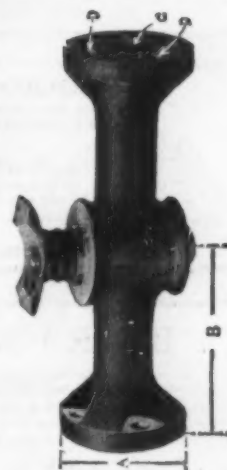


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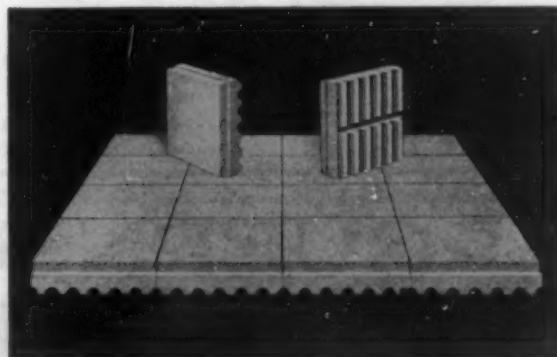
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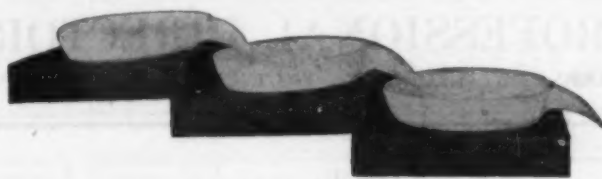
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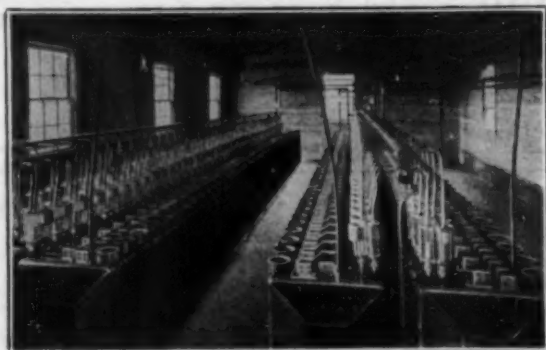
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1070-D	5 x 30-ft.
1070-E	4 x 20-ft.
Other Types:	
969-E	Westchester Lime, 3 x 24-ft., with steel flights instead of brick lining.
1060-B	Bonnot, 6 x 40 ft.
1118-A	American Process, 4½ x 25-ft.

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110-D	Oriscom & Russell, triple effect, 750-gal. per hour at 5-lb. steam, copper tubes.
561-A	Zarembs, 3000-lb. per hour at 5-lb. steam pressure and 20-in. vacuum-steel tubes.

584-A	Buffalo Foundry, horizontal tube, 1000-lb. at 40 lb. steam per hour and zero in vapor space, copper tubes.
204-D	30-in. x 12-ft. vertical evaporator, 3500-lb. water per hour.
553-A	Zarembs steel tubes, 75 gal. per hr. at 5-lb. steam.

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204-C	(5) 42-in. dia. x 5-ft. deep, cast iron with agitator; no jacket.
110-FF	Open cast iron, 60-in. dia. x 24-in. deep
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580-A	No. 9—31-in. dia., 97-in. long.
848-BH	No. 9—31-in. dia., 97-in. long.
590-B	No. 10—31-in. dia., 109-in. long.
848-CC	No. 10—31-in. dia., 109-in. long.
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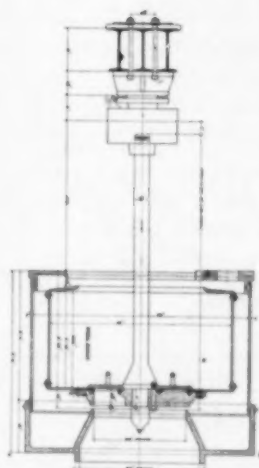
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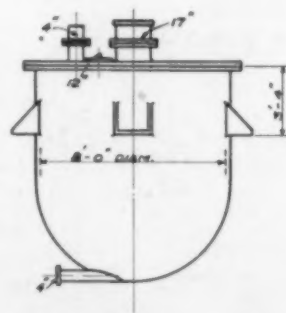
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NITRIC RETORT

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- 1—1300 hp. Blake Heater.
- 1—1300 hp. Berryman Heater.
- 1—200 hp. Reilly Multicoil Heater.
- 1—200 hp. Berryman Heater.

Also vertical types in stock.

All sizes of Tanks, open and closed, suitable for storage of gasoline or fuel oil, in stock at our Boston Yard.

**THE PERRY, BUXTON, DOANE CO.**  
214 W. First St., So. Boston, Mass

## TANKS

### New, Ready to Ship

- 1—740,000 gal., 60 ft. x 35 (vert.)
- 2—55,000 gal., 23 ft. 3 in. x 17 ft. 6 in. (vert.)
- 2—18,500 gal., 10 ft. x 32 ft. (hor.)
- 9—2300 gal., 5 ft. x 16 ft. (hor.)
- 3—1300 gal., 6 ft. 6 in. x 5 ft. 9 in. (vert.)
- 1—35,000 gal., 75 ft. Tower Tank.

### TUBE MILL—New

7 ft. x 22 ft. Bethlehem Foundry & Machine Co.

**J. ALEX. MAYERS**  
Engineer and Contractor  
55 William St., New York City

## BOILERS

### Immediate Shipment

- 3—72-in. x 18-ft. Hor. Tub., 125-lb. St., \$1500 each.
- 2—66-in. x 16-ft. Hor. Tub., 125-lb. St., \$1000 each.
- 2—60-in. x 16-ft. Hor. Tub., 125-lb. St., \$750 each.
- 2—400-hp. Wickes W.T., 150-lb., \$5500 each.
- 2—300-hp. Wickes W.T., 150-lb., \$4000 each.
- 1—200-hp. Manning Vertical, 125-lb., \$3000.

Send for complete stock list.

**WICKES MACHINERY CO.**  
America's Largest Machinery House  
Jersey City, N. J.

## FILTERS

- 2—12 x 10 Portland Continuous.
- 1—12 x 10 Oliver Continuous.
- 1—12 x 9 Portland Continuous.
- 1—12 x 7 1/2 Portland Continuous.
- 1—6 x 4 Portland Continuous.
- 1—Moore Type, A 4563 ft. Filtering Surface, complete with two baskets, loading, barren, wash and acid tanks, traveling crane, 400 ton capacity.
- 1—Kelly 850 ft. Area, 100 dry ton capacity.
- 3—24 x 30 Plate and Frame Stearns-Rogers, 20 frames.
- 6—42 x 42, 650 ft. capacity, Shriver Plate and Frame.
- 1—24 x 24 Plate and Frame Vulcan, 7 frames.
- 1—18 in. Perrin Square recessed plates, 10 plates.
- 1—18 in. Johnson round recessed plates, 21 plates.
- 1—24 in. Shriver square plate and frame, 24 frames.
- 1—24 x 30 S. & R. plate and frame, 24 frames.

Vacuum Pumps, Compressors, Pulp Pumps, Receivers, in stock.  
Immediate shipment from Denver.  
**The Morse Bros. Machinery & Supply Co.**  
DENVER, COLO.

### FOR SALE

- 3—330 H.P. and 2—400 H.P. Erie City Horis.

## WATER TUBE BOILERS

each complete with boiler supports, fronts, clean out doors, trimmings and standard fittings and Green Chain Grate Stokers, complete with arches and up to and including ratchet drive and a large supply of spare parts. 4 units available immediately, 1—400 H.P. unit available Jan. 1st. Hartford inspection rating 160 lb.

FB-625—Chem. & Met. Eng.  
10th Ave. at 36th St., New York City

## RELAYING RAIL

- 1400 Tons 40-lb. No. 1 with angle bars
- 200 Tons 56-lb. No. 1 with angle bars
- 400 Tons 61-lb. No. 1 with angle bars

All immediate shipments from our yards, Denver, Colo.  
**The Morse Bros. Machinery & Supply Co.**  
Denver, Colo.

## 3 1/2-FOOT MARION DREDGE

Continuous 3 1/2 cu. ft. Marion Gold Dredge. Bucket ladder 60 ft. centers. Stacker 75 ft. Three phase, 60 cycle, 440 volt electrically operated throughout. Wood Hull, 38 by 85 ft. Good as new.

**The Morse Bros. Machinery & Supply Co.**  
Denver, Colo.

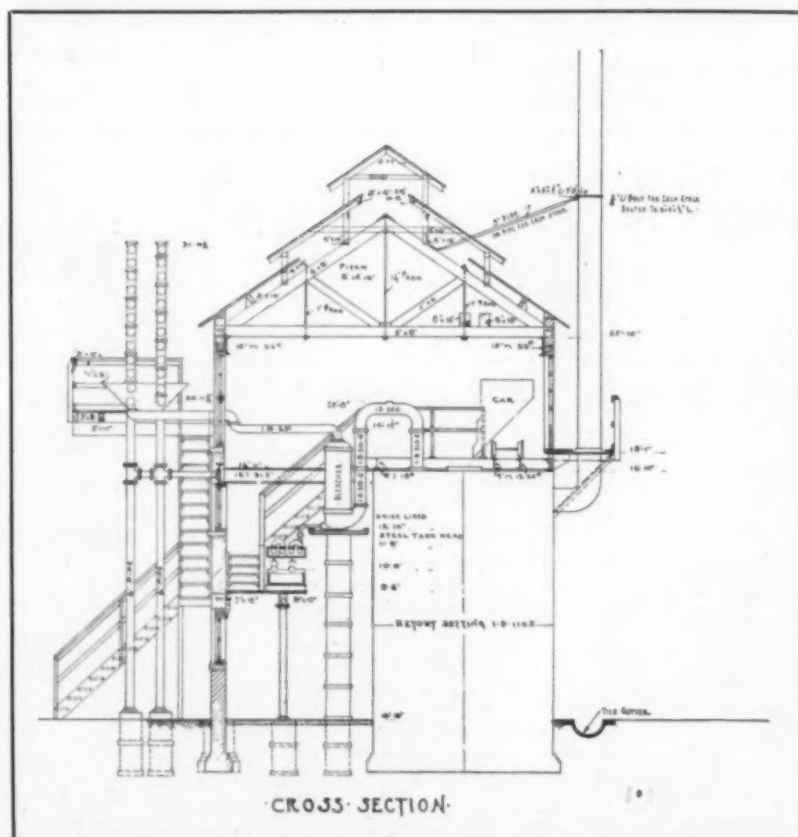
## Reconstruction! Re-equipping! Resuming!

Will **you** be one of those who were **not** ready?

**Business as usual—NOW**

## FOR SALE

# NEW NITRIC ACID PLANT



COMPLETE  
WITH  
BUILDING READY FOR ERECTION  
FOUR DOUBLE UNITS  
ALSO  
SLIGHTLY USED PLANTS  
OF  
SIMILAR DESIGN

GEORGE C. HOLT & BENJAMIN B. ODELL, RECEIVERS OF  
**AETNA EXPLOSIVES COMPANY, INC.**  
120 BROADWAY, NEW YORK

APPLY TO ENG. & CONSTR. DIVISION



### Plain and Steam Jacketed Kettles, Autoclaves, Retorts and Other Chemical Apparatus

of  $\frac{1}{8}$ - to  $\frac{5}{8}$ -inch material, lined with tin, lead and copper; corrugated transformer tanks and various pressed steel articles.

### BUILT on CONTRACT

We have a large shop, employ ten welders and other skilled labor, have been in business six years and can guarantee prompt and satisfactory service. Let us know your requirements.

**YOUNGSTOWN WELDING CO.**  
536 W. Rayen Ave., Youngstown, Ohio

### FOR SALE

### One No. 9 Vesuvius Sulphur Burner

Has never been erected. Can be shipped immediately.

FS583—Chemical & Metallurgical Engineering  
10th Ave. at 36th Street, New York

### THE SEARCHLIGHT SECTION

will locate the { Man you want  
Position you want  
Equipment you want

ARE YOU USING THE SEARCHLIGHT?

### RELAYING RAIL

170 Gross Tons 60-lb.  $5\frac{3}{4}$ -in. High Relaying T Rail, with continuous Joint Plates; in good, serviceable relaying condition, but will not pass Hunt's inspection. Price, \$48.40 per gross ton, f.o.b. cars East St. Louis.

**ARTHUR S. PARTRIDGE**  
415 Pine St., St. Louis

### FOR SALE

### REVOLVING VACUUM DRUM

Hermetically sealed; capacity 220 gal.,  $\frac{1}{4}$ -in. steel; octagonal shape. Complete with pressure and vacuum gauges, observation window, etc.

For chemical laboratory or small plant.

**ANCHOR COMPANY**  
Pawtucket, R. I.

### BALL MILLS

No. 54 Marcy.  
6 x 16 Hardinge.

**The Morse Bros. Machinery & Supply Co.**  
DENVER, COLO.

### LOCKERS

Will buy 100 to 150 metal lockers in good condition. Delivery at New York. Give specifications and prices.

**McGRAW-HILL CO., Inc.**  
10th Ave. at 36th St., New York, N. Y.

### Located at Carrollville, Wis.

- 2—7-ton Vilter Ammonia Compressors, with 8 in. x 9 in. compressor cylinder, and 10 in. x 11 in. steam cylinder.
- 1—Brine Tank, 14 ft. x 9 ft. x 4 ft. 3 in. deep, made of  $\frac{1}{4}$  in. steel plate, for 8 banks of  $1\frac{1}{4}$  in. pipe (4 banks of pipe missing).
- 1—Double Pipe Ammonia Condenser, with following parts missing: One 8 in. x 14 in. Liquid Ammonia Receiver, one Oil Separator. Apparatus in fair condition.
- 1—No. 2 Sturtevant "Open Door" Rotary Crusher.

### Located at Mayville, Wis.

- 2—Holmes Patent Rotary Gas Scrubbers, built by Western Gas Construction Co.
- J. P. McGUIGAN, Purch. Agt.**  
1101 First Nat. Bank Bldg., Milwaukee, Wis.

We have for sale two

### ROTARY DRYERS

In first-class condition for immediate shipment.

**HENRY H. WOOD, INC.**  
68 Beaver Street, New York City

### GYRATORY CRUSHERS

No. 5 Gates	Side Discharge
No. 5 Austin	Standard Discharge
No. 5 McCully	Side Discharge
No. 3 Austin	Standard Discharge
No. 1 Gates	Standard Discharge

All Immediate Shipment From Our Yard

**The Morse Bros. Machinery & Supply Co.**  
Denver, Colo.

### TWO

### VACUUM PUMPS

8 in. x 10 in. x 12 in. Simplex brass fitted, in service only thirty days, first-class condition. Made by Marsh Steam Pump Company, Battle Creek, Mich. Immediate delivery subject to prior sale.

**The Western Gas Construction Company**  
Fort Wayne, Indiana

5000 HP. Approx. Jones Patented Under Feed

### Stokers

All physical and mechanical condition—Discontinued from service only on account of increased Stoker capacity per boiler required.

**PAUL STEWART & CO.**  
Electrical & Steam Machinery  
First National Bank Bldg., Cincinnati, O.

### One

### STILL

21 $\frac{1}{2}$  ft. long, 5 ft. dia., 166 3-inch tubes, shell  $\frac{1}{2}$  inch, heads  $\frac{3}{8}$  inch.

### One Rotary Steam

### DRYER

6 ft. dia., 33 $\frac{1}{2}$  ft. long, 52 2-inch tubes. Complete with stack.

Practically new

**JOHN NUTTALL**  
1748 N. Fifth St., Philadelphia, Pa.

### WANTED

One Single Table

### Wyzor Polishing and Grinding Machine

For Preparing Micrographic Specimens

**Electrical Testing Laboratories**  
80th Street and East End Avenue  
NEW YORK, N. Y.

### AERIAL TRAMWAYS

3000-ft. Laschen Smooth Coil Cables, complete.  
3300-ft. Bleichert Smooth and Lock Coil.  
1200-ft. Jig Back Tramway, 17 cu.ft. buckets.

**The Morse Bros. Machinery & Supply Co.**  
DENVER, COLO.







FOR SALE  
**MODERN LABORATORY**  
*Established 16 Years*  
City of 225,000  
**EXCELLENT LIBRARY AND EQUIPMENT**  
P-634—Chem. & Met. Engrg.  
657 Leader-News Bldg., Cleveland, Ohio

FOR SALE  
350 Cases Hardened Soya  
**BEAN OIL**  
50° Titre.  
200 Barrels  
**HARD GREASE**  
47° Titre.

Samples from  
**I. LEVINSTEIN & CO., INC.**  
Framingham, Mass.

FOR SALE

Filter Press

For sale, 32"-50 plate c. i. filter press, centerfeed, bottom discharge. Now in service. E. E. Norris, Chicago Heights, Ill.

POSITIONS VACANT

A FOUNDRY foreman wanted to take complete charge of an iron and brass foundry in Havana, Cuba, employing approximately 100 men, speaking Spanish, manufacturing sugar mill machinery and handling general jobbing shop work. Must have administrative experience and be able to direct work on mill rolls, castings, evaporator 14 ft. in diameter, melting and mixture of metals. One experienced in sweep molding work. Knowledge of Spanish very useful. Excellent opportunity for the right man. Results wanted. State age, married or single, references in detail and salary expected. P-664, Chem. & Met. Engrg.

A MAN wanted to be head of operating of chemical plant. Must have practical experience and be able to suggest profitable lines of further development. College graduate preferred. Salary in accord with ability. In replying give briefly age, experience, reference, etc. P-669, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

BLAST furnace foreman wanted, with converter experience, for work in South America. Three year contract. Transportation paid to and from property. Submit experience, state whether familiar with Spanish or not. P-607, Chem. & Met. Engrg.

CHEMIST wanted; trained in quantitative analysis; familiar with pig iron, iron ore, and general volumetric analysis. Wanted for charcoal blast furnace and wood distillation plant. Salary to start \$100 per month. Address "Wood Alcohol," P-662, Chem. & Met. Engrg.

GRADUATE chemical engineer wanted; 25 to 28 years of age with experience in chemical manufacturing to engage in development and sale of apparatus for chemical manufacturing operations. P-637, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

PHYSICIST, physical chemist, or engineer wanted by leading manufacturing corporation to study high-temperature gas-furnace design. Experience desirable but training and capability of more importance. Permanent position with unusual possibilities for the future. Advise fully regarding yourself. P-636, Chem. & Met. Engrg.

PLATINUM refiner—A man who thoroughly understands the refining, melting and rolling of platinum. State experience and salary desired. P-652, Chem. & Met. Engrg.

NEW and  
SECOND  
HAND  
GLUCK BROS.

**DRUMS**

BOUGHT  
and SOLD

ANY KIND AND SIZE

Perth Amboy, N. J.

**ARSENIC MINE AND SMELTER**

Arsenic smelter and mine complete; mineral rights 103 acres; fully equipped for production of high-grade White Arsenic. Mine pumped and mill ready for immediate operation. Underground development has progressed to main two-compartment shaft several hundred feet, with drifting on the lower level through 600 feet of ore. Not a prospect. Mine electric lighted; fully equipped with modern machinery and smelter, thoroughly tested. General property laid out for extensive operation, including miners' dwellings, commissary, tractors, trucks, timber lands; inventory on request. Location convenient to Eastern market.

P-633—Chem. & Met.  
10th Ave. at 36th St., New York City

POSITIONS VACANT

METALLURGIST wanted. Recent technical graduate, for work in physical laboratory of steel company on routine and research work. State qualifications, references and salary desired. P-635, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

STEEL works laboratory wants young men just out of college. Good opportunity for man that is earnest and reliable. No others need apply. State age, nationality, education and other qualifications. Address P-616, Chem. & Met. Engrg.

POSITIONS WANTED

ASSISTANT chemist; 22, 3 years' technical training, 6 months' practical experience, desires position in New York or vicinity. PW-640, Chem. & Met. Engrg.

ASSISTANT superintendent, practical man, 16 years' experience in chemical lines, desires position as superintendent or assistant or department manager. Good organizer and systematizer. Age, 39. PW-641, Chem. & Met. Engrg.

CHEMIST, graduate, 33 years old, having been in charge of fertilizer, cotton seed oil and sugar laboratory with wide experience in miscellaneous analytical work, chemical factory control and some research work wants to change his position. PW-638, Chem. & Met. Engrg., Chicago.

CHEMIST and metallurgist; with many years' experience in general chemistry and metallurgy, in New York and the West, will be open for an engagement Jan. 1st, 1919. Address PW-647, Chem. & Met. Engrg.

CHEMIST, 24, college graduate with 2 years' experience in the manufacture of benzoic acid and benzoate of soda, also experienced in other lines, desires position with well established concern where prospects of advancement are good. At present employed. PW-648, Chem. & Met. Engrg.

CHEMICAL engineer, 3 years' experience in research, design, construction, operation, control and superintendent of plant manufacturing intermediates and dyes. Developed one complete process. Would like to connect with concern interested in manufacture and development of intermediates and dyes. PW-639, Chem. & Met. Engrg., Chicago.

POSITIONS WANTED

CHEMICAL engineer—Recent graduate of M. I. T. At present employed in one of the largest plants in United States, desires operative position in manufacture of organic products in New York City or immediate vicinity. PW-649, Chem. & Met. Engrg.

CHEMICAL engineer opening office London, England, desires representation of American specialties. PW-665, Chem. & Met. Engrg.

CHEMICAL engineer and metallurgist, graduate of Mass. Inst. of Technology; 3 years' experience in general research and metallography and heat treatment of carbon and alloy steels, desires position in work along these lines. Must be good opportunity for advancement. Location, East preferred. PW-661, Chem. & Met. Engrg.

CHEMICAL engineer and metallurgist, experienced on the production of the ferro-alloys in the electric reduction furnace. Will consider position as chemical engineer or metallurgist with any first-class concern. Capable of doing development work. Good references. Salary \$3000. PW-656, Chem. & Met. Engrg., Rialto Bldg., San Francisco.

CHEMICAL engineer, university graduate, age 32, single; experience in oil, gas and acids, desires position supervising operating department of a growing concern. At present employed. Address PW-657, Chem. & Met. Engrg.

**TECHNICAL EXECUTIVE**

University graduate with experience in chemical and mechanical engineering. Must be trained in fuel, gas and metallurgical chemistry, refractory materials and high temperature measurements. Must be familiar with commercial laboratory methods and furnace practice, able to carry on individual research and handle men. Selling ability highly desirable. To the right man the position offers an opportunity to make his personality felt in an interesting and rapidly developing field.

*Applicants will call for a personal interview with*

**MR. PRUDEN, President**  
of the Powdered Coal Engineering & Equipment Company,  
2401 Washington Boulevard,  
Chicago, Ill.



# Get Your Wants into the Searchlight

## ADVERTISING RATES

### Ads Set in Uniform Style

(Sold, in one paragraph, without display.)

**THREE CENTS A WORD**, minimum charge 50 cents an insertion, payable in advance, less 10 per cent, if one payment is made in advance for four continuous insertions—for advertisements under:

Positions Wanted	Vacation Work Wanted
Evening Work Wanted	Tutoring
	Salesman Wants Connections

**FIVE CENTS A WORD**, minimum charge \$1.50 an insertion, for advertisement under:

Agencies Wanted	Positions Vacant
Agents Wanted	Partner Wanted
Business Opportunities	Representations Wanted
Desk Room for Rent	Salesmen Wanted
Educational	Patents for Sale
Employment Agencies	Plans for Sale
Desk Room Wanted	Sub-Contracts Wanted
Foreign Business	Work Wanted

Miscellaneous for Sale, for Rent or Want Ads.

**THIRTY CENTS A LINE**, minimum five lines, for all undisplayed advertisements set with a paragraph for each item or tabulated.

**THREE DOLLARS AND SIXTY CENTS AN INCH** for advertisements for bids (Official Proposals).

### Ads Set in Display Type

(Individual space, within border rules.)

Space for these advertisements is sold by the inch. Each page contains 30 inches. The rate per inch is based on the total number of inches to be used—that is, the number of inches the advertisement is to occupy multiplied by the number of insertions it is to receive. For instance, a 2-inch advertisement in 2 issues earns the 4-inch rate of \$2.90 an inch. A 1-inch space in 4 issues, or a 4-inch space in one issue, also earn the 4-inch rate.

#### SCHEDULE OF RATES

1 to 3 in.	\$3.00 an in.	15 to 25 in.	\$2.70 an in.
4 to 7 in.	2.90 an in.	27 to 49 in.	2.80 an in.
8 to 14 in.	2.80 an in.	50 to 99 in.	2.50 an in.

Rates for larger space furnished on request.

*For quick and satisfactory results  
tell the reader everything that  
he will want to know.*

## INFORMATION

ALLOW FIVE WORDS for the address. If replies are to a box number in care of any of our offices. There is no extra charge for forwarding replies.

IN REPLYING TO ADS, do not enclose original testimonials or anything that you may want returned. State your experience and qualifications in as concise and neat a manner as possible and enclose copies of your testimonials.

BE CAREFUL TO PUT ON ENVELOPE, when answering any "blind," ad, the box number in the ad, the name of the paper, and also the local address of office to which reply is sent:

36th St., at 10th Ave.	New York
935 Real Estate Trust Bldg.	Philadelphia
657 Leader-News Bldg.	Cleveland
1570 Old Colony Bldg.	Chicago
619 Newhouse Bldg.	Salt Lake City
501 Rialto Bldg.	San Francisco

WHEN ADVERTISING MACHINERY, use your own name and address—or a local address of some kind—so that the readers can wire direct and get quick replies. We advise also that you state in your advertisement the present location of plant that is offered for sale, or point of delivery provided you are in the market for equipment.

TO SIGN YOUR NAME and address to your advertisement beguets the confidence of the reader and facilitates receiving replies. You can, however, obviate delay in receiving answers by signing your ad. only with initials (your own or others), care of your home, your office or a post-office box number in your city.

## POSITIONS WANTED

**CHEMICAL** engineer, age 24, University graduate with excellent scholastic and industrial record, upon his release from the Chemical Warfare Service this month, desires a position in plant supervision, or industrial research, where he will have an opportunity of utilizing his energy and ability; will gladly furnish references and details of experience to interested principals. PW-650, Chem. & Met. Engrg.

**CHEMICAL** engineer, experienced, best references, seeks position. Explosives plant preferred. Good knowledge of high explosives. PW-695, Chem. & Met. Engrg., Philadelphia.

**CHEMICAL and Metallurgical Engineer**—Position as executive. Chief chemist or superintendent, 8 years chief chemist and superintendent acid plant and smelters. Experience in iron and steel, zinc, copper, ferrous and non-ferrous alloys. Position of responsibility anywhere. Presently employed by large copper company. Draft exempt. PW-522, Chem. & Met. Engrg., San Francisco.

**CHEMICAL** engineer, university graduate, age 27, now lieutenant, Ordnance, U. S. A., desires position on leaving service. Has executive ability; familiar with plant operation; 3½ years' experience ferro alloys; vanadium molybdenum, tungsten, and their allied products and compounds. PW-611, Chem. & Met. Engrg.

**CHEMICAL** engineer, university graduate, thorough theoretical training, and extensive and varied practical experience in factory and laboratory, especially inorganic and non-ferrous metallurgy, as chemist, chief chemist and executive; only permanent, high-grade position considered; exempt. PW-577, Chem. & Met. Engrg.

**CHEMICAL** engineer, Columbia 1917, analytical organic experience, desires change. 25 years old, Hebrew, American citizen, married, draft exempt. Minimum salary, \$2000. PW-570, Chem. & Met. Engrg.

**CHEMICAL** engineer, age 24, at present in charge of laboratory of large electro-metallurgical concern, desires position offering opportunities in technical field not devoted exclusively to chemistry. PW-596, Chem. & Met. Engrg.

**CHEMICAL** engineer, operating, control, research and laboratory experience, thorough university training. Age, 34. Interested in business end of the industry as well as in the technical end. PW-442, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

## POSITIONS WANTED

**CHEMIST**, at present chief chemist in a laboratory for the testing of explosives, desires a position in or near Philadelphia. Technical graduate with several years' experience covering teaching; plant control and process work on organic products. Best references. PW-643, Chem. & Met. Engrg., Philadelphia.

**CHEMIST**, graduate with 6 years of unusually good experience embracing analytical research and plant operation, desires position either in plant or laboratory. PW-645, Chem. & Met. Engrg., Philadelphia.

**CHEMIST**, 26 years old, B.S. in chemistry; 4 years' experience in the manufacture of acids, nitration products, intermediates and dyestuffs. Has laboratory and plant experience in both industries. Formerly a research fellow in an eastern university. At present employed, but desires to make a change shortly and wishes employment with a dyestuff concern, as a research chemist. Can furnish highest credentials regarding ability. Position must be in or near New York City. PW-659, Chem. & Met. Engrg.

**CHEMIST**, good analyst and research worker. At present employed in light oil plant, desires change. Vicinity of New York City preferred. PW-660, Chem. & Met. Engrg.

**CHEMIST**, college graduate, 2 years' practical training in the manufacture of aniline dyes and intermediates, wants responsible position. PW-670, Chem. & Met. Engrg.

**CHEMIST**, college graduate with experience in light oil and coal gas plant. Have thorough, complete and general technical training and would consider position with any important industry in New York City or vicinity. PW-655, Chem. & Met. Engrg.

**CHEMIST**, graduate, experienced analytical work on dyestuff intermediates, desires position; preferably in organic plant with chance for advancement and opportunity to gain plant experience; New York or vicinity. PW-671, Chem. & Met. Engrg.

*Keep your eye on the  
Searchlight and your  
advertisements in it.*

## POSITIONS WANTED

**CHEMIST**, 27, seven years' laboratory and plant experience in gas and light oil work, desires position. PW-609, Chem. & Met. Engrg.

**CHEMIST**, B. S., now employed, seeks to change to position offering future; 2 years' experience in laboratory, and some in plant control; willing to start at moderate salary. PW-681, Chem. & Met. Engrg., Philadelphia.

**CHEMIST**, college graduate, 2 years' analytical experience, desires position; plant preferred. PW-668, Chem. & Met. Engrg.

**CHEMIST**, age, 25 years, college graduate, desires responsible position where training and ability count. Have been in charge of analytical laboratory two years, have had one year's experience in plant operation. Can give good references as to my training and ability. Address Chemist, Box 287, Gainesville, Fla.

**METALLOGRAPHIST**. Experienced metallographist, unmarried, wanted for steel works abroad, to manager laboratory containing modern outfit for metallographic and physical tests. Specialty electric alloy steels. Applicant must have full technical education. Traveling expenses advanced and contract made if references, qualifications and experience are satisfactory. Write PW-683, Chem. & Met. Engrg., Philadelphia.

**EXPERT** analyst, graduate chemist, 8 years' experience in the analysis of heavy chemicals. Thorough training along inorganic lines. At present employed as assistant chief, with a chemical plant employing fifteen chemists. Wish to make a change. Vicinity Chicago only. PW-676, Chem. & Met. Engrg.

## GRADUATE METALLURGICAL ENGINEER

specialist in metallography, heat treatment and alloy steels, who has headed laboratory and research work, desires to relocate. Experience covers treatment of gases, threading tools and machinery, ferrous materials and non-ferrous alloys in ammunition products and airplane engines. Executive ability is combined with familiarity with factory methods and procedure.

PW672—Chem. & Met. Eng.  
10th Ave. at 36th St., New York City





POSITIONS WANTED

GRADUATE chemist, 29 years of age, 5 years' experience in government laboratory, 3 years' experience with large manufacturing concern. Experience covers a particularly wide range of inorganic analysis, with some organic. At present chief chemist in laboratory employing 12 chemists. Has executive ability. Desires change to position with more opportunities. Has knowledge of Spanish. PW-675, Chem. & Met. Engrg.

GRADUATE chemist, thorough technical training, 2 years' practical experience in plant, research and laboratory as chemist and laboratory supervisor, desires permanent position with progressive concern. PW-651, Chem. & Met. Engrg.

GRADUATE chemist wants change. Practical experience on explosives, ores, metals, and steel materials. Married; 27; will go anywhere. E. S. J., 149 South Street, Houghton, Mich.

GRADUATE Western college who has had charge of Government Metallurgical Laboratory during past war would consider position as Metallurgical Chemist with some prominent concern. Address PW-646, Chem. & Met. Engrg.

HIGH-grade chemical engineer and proven executive will be released from Government service about January 15. Graduate engineer with 2 years' additional training in business administration. Now chief executive and technical expert at one of America's largest explosives plants. 4 years' experience in production, and also sales distribution. Married. Desires connection where compensation is commensurate with demonstrated ability. Address PW-654, Chem. & Met. Engrg., Chicago.

I HAVE had 8 years' experience in chemistry, including metallurgy and photomicrography. For 6 years I have held a responsible position as chief chemist and executive. Seeking a position with broader field which will lead to some road work. Best references. B.S. and M.Sc. degrees. Present salary \$3000. Would consider less if future prospects warrant. PW-658, Chem. & Met. Engrg., Chicago.

INDUSTRIAL chemist and manager, 8 years' plant experience. University graduate, age 33, married. Experienced in causticizing, multiple effect evaporation, nitric acid, ammonium nitrate, compressed gases, oils and waxes. Successful in handling labor, development of new methods and getting results. Salary, \$3000. PW-684, Chem. & Met. Engrg.

INORGANIC chemist desires position, either as analyst or executive. A man with a push desires an opportunity. PW-667, Chem. & Met. Engrg., Philadelphia.

JUNIOR chemist, with international correspondence school training, desires to change present situation, preferably along organic or manufacturing line, proficient knowledge. PW-599, Chem. & Met. Engrg.

JUST released from U. S. Service. Chemical engineer (26) University graduate with special schooling along electro-chemical, metallurgical and industrial chemistry lines. Would like employment with manufacturer as supervisor of work or in the testing materials laboratory. Location immaterial. PW-674, Chem. & Met. Engrg.

MECHANICAL and structural engineer, resourceful; 12 years' high-class experience industrial plant design, construction, equipment and supervision, piping systems, special apparatus; familiar with coal tar products plants. Employed at present, but will consider offer for good position with growing concern for after the first of the year. PW-653, Chem. & Met. Engrg.

METALLURGICAL engineer, college graduate, with many years' experience as chemist, electric furnace operator and metallurgist, desires position. PW-621, Chem. & Met. Engrg.

METALLURGICAL chemist desires position as chief chemist or metallurgist. Now employed as consulting iron metallurgist and research engineer in metallurgy on aircraft. PW-679, Chem. & Met. Engrg.

POSITIONS WANTED

MECHANICAL and structural engineer. 18 years' practical experience design and construction of steam power plants, chemical plants, industrial and manufacturing plants, mill buildings, heating, ventilating, etc. Available on short notice. PW-602, Chem. & Met. Engrg.

METALLURGIST and metallographist: 5 years' experience in microscopic research on ferrous and non-ferrous metals; 4 years' practical experience in the manufacture, heat treatment, physical testing and machinability of tool steels, alloy steels, high-speed steels. Capable of solving metallurgical problems or carry on research work. Can furnish excellent references. PW-663, Chem. & Met. Engrg.

METALLURGICAL chemist, graduate in chemical engineering, thorough knowledge of inorganic and analytical chemistry, desires a position as research chemist. Experienced in the production and analysis of tungsten, molybdenum and other rare metals, and in investigative work. At present in charge of a metallurgical laboratory. Capable of handling plant problems such as utilizing byproducts, improving methods or developing new processes. Prefer a position paying a nominal salary with a bonus for successfully completed researches. PW-632, Chem. & Met. Engrg., Philadelphia.

METALLURGIST, with experience in metallography, university graduate; at present employed, but desires change. PW-620, Chem. & Met. Engrg.

METALLURGIST — Government metallurgist desires executive position with progressive firm. Technical graduate with eight years' experience with ferrous and non-ferrous metals for manufacturing and consuming interests. Can handle men and get results. PW-677, Chem. & Met. Engrg.

PHYSICAL chemist acquainted with fuels and high temperatures, \$2500. D., 702 Church St., Ann Arbor, Mich.

POSITION as supervisor or foreman in a chemical plant where knowledge of chemistry would be useful, and where there would be a chance for advancement. Have had 5 years' experience in the manufacture and analysis of acids and explosives. Can handle men. At present in charge of an acid laboratory. Available after Dec. 6. Willing to accept reasonable salary; location immaterial. PW-650, Chem. & Met. Engrg.

SUPERINTENDENT or similar position, age 33, draft exempt, 5 years in large plant as superintendent of maintenance and construction of buildings, steam and water piping and general utility departments; engineering and commercial office experience. PW-592, Chem. & Met. Engrg.

SUPERINTENDENT, a capable man of experience and education, desires a position as superintendent or supervisor of plant work in metallurgy or chemical manufacture, or ore reduction. Now chief chemist for a large iron plant. Qualified for almost any position in metallurgy. Open for engagement about January. PW-591, Chem. & Met. Engrg., Chicago.

TECHNICAL Director, B. S. (chemical engineering), Ph.D. Success as an executive and developer of industrial processes assured by 15 years' experience; 18 patents, 45 scientific articles. Qualified in inorganic chemistry, analytical chemistry, geology, metallurgy and physical chemistry including electro-chemistry. Experienced in battery, gas and starch manufacture. Seek position offering greater opportunity for advancement. PW-644, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

YOUNG analyst, 23, hard worker, thorough technical training in chemistry, 4 years' experience in analytical work on a broad scope, specially in ferro and non-ferro alloys and steel works materials, but trained to adapt himself to any line, desires a position with a future for a man who can demonstrate what he can do. Salary no object at the outset. PW-600, Chem. & Met. Engrg., Philadelphia.

POSITIONS WANTED

TECHNICAL man, accustomed to responsible operating and construction work, is open for immediate engagement. Especially competent in problems involving fractional distillation, evaporation absorption, leaching and extraction and filtration. Minimum salary \$3000. PW-666, Chem. & Met. Engrg.

AGENTS AND SALESMEN

**Agency for Contractor's Equipment**  
Do you wish to be represented among the contractors of New Jersey. If they are good, we know them. Write Room No. 614, American Mechanic Bldg., Trenton, N. J.

**Salesman to Sell Pumps**  
Wanted—To get in communication with salesman to handle a line of rotary, centrifugal and force pumps selling to the jobbing trade. State fully experience and complete information, which will be treated confidentially. Engagement first of the year. Address Taber Pump Co., 291 Elm St., Buffalo, N. Y.

**Agency for Contractors' Equipment**  
Attention Manufacturers—We can sell your mill equipment in New Jersey. We have best connections through live wire representatives. Letter will insure interview. Inquiries will be treated confidentially. Room No. 614, American Mechanic Bldg., Trenton, N. J.

**Installation Engineers and Sales Engineers**  
Wanted competent young men with electrical education and training, to travel in the big industrial and manufacturing districts, calling on superintendents, managers and engineers of factories, power and light companies, iron and steel works, chemical plants, coke and gas works, etc., to sell, install, test and investigate in service well known line of electrical and temperature equipment. High grade work, well paid, with unusual opportunities for development and advancement. Men with sales experience or skill in handling electrical instruments preferred. Write describing education and experience. State age and salary desired. AS-673, Chem. & Met. Engrg.

**Agencies Wanted in France**  
Chemist and engineer with technical and business experience in France and America would like to represent American manufacturers in France. AS-678, Chem. & Met. Engrg., Chicago.

EMPLOYMENT AGENCIES

CHEMISTS with experience in iron and steel as well as many other industries wanted for new opportunities in various parts of the country. 25 years' experience in engineering personnel work. Address Chemical Department, The Engineering Agency, 1662 Monadnock Bldg., Chicago.





Employment Service

The undersigned provides a confidential service designed to locate openings through correspondence for men earning not less than \$2,500 and up to \$25,000; all lines. Not an employment agency, but a constructive, initiative service, covering individual negotiations. Established 1910. Complete privacy assured; present connections in no way jeopardized. Send name and address only for explanatory details. R. W. Bixby, D64-66 Niagara Street, Buffalo, New York.

**NEED A  
Mill  
Superintendent?**

Assayer, Chemist,  
Engineer?  
Wire or write  
Business Men's  
Clearing House  
Denver, Colo.



	<h1 style="text-align: center;">DO IT THROUGH BAKER</h1>	
<p>Crucibles</p> <p>Combustion Apparatus</p> <p>Dishes</p> <p>Pans</p> <p>Triangles</p> <p>Filter Cones</p> <p>Gauze Electrodes</p>	<p>The refining and repairing service of <i>the largest workers of platinum in the country</i> is back on a pre-war basis.</p> <p>Restrictions have been removed so that we can supply all your needs in platinum laboratory apparatus.</p> <p>Old crucibles, dishes and appliances of all forms reshaped, repaired, purchased or exchanged for new ware.</p> <p>Standard laboratory platinum ware can be supplied from stock. Special equipment made to order on the shortest notice. Our experts gladly advise you regarding the practicability of any idea for the use of special platinum apparatus.</p> <p style="text-align: center;"><i>If you have no copy of "Data Concerning Platinum" send for one.</i></p>	<p>Electrolytic Separation Apparatus</p> <p>Spoons</p> <p>Tweezers</p> <p>Stirring Rods</p> <p>Tongs</p> <p>Platinum Wire Sheet</p> <p>Sponge Salts and Solutions</p>
	<p style="text-align: center;"><b>Baker &amp; Co., Inc.</b> Murray and Austin Streets Newark, N. J. New York Office: 30 Church Street</p>	

# WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used by the Chemical, Metallurgical and Allied Industries with Names of Manufacturers and Distributors

For Alphabetical Index See Page 152

**Acid Concentration Apparatus**  
Chemical Construction Co.  
Duriron Castings Co.  
International Glass Co., The  
Kilberry Corp., The  
Pratt Eng. & Machine Co.  
Thermal Syndicate, Ltd., The

**Acid Distillation Apparatus**  
Buffalo Foundry & Machine Co.  
Pratt Eng. & Mach. Co.  
Thermal Syndicate, Ltd., The

**Acid Eggs, Cast Iron**  
Bethlehem Fdry. & Mach. Co.  
Buffalo Fdry. & Mach. Co.  
Devine Co., J. P.  
Ellyria Enamelled Products Co.  
Lummus, The Walter E. Co.  
Monarch Mfg. Works  
Stearns-Roger Mfg. Co.  
Stuart & Peterson Co.  
U. S. Cast Iron Pipe & Fdry. Co.

**Acid Eggs, Stoneware, Acid Proof**  
Knight, Maurice A.  
Monarch Mfg. Works  
Pratt Eng. & Mach. Co.  
U. S. Stoneware Co.

**Acid Resisting Glass Enamelled Apparatus**  
See Enamelled Apparatus, Acid Resisting

**Acid, Sulphuric**  
See Enamelled Ware, Glassware, Porcelain, Silica and Stoneware

**Agitating Machinery**  
Caldwell, W. E. Co.  
Werner & Pfleiderer Co., Inc.

**Agitator Tanks, Wood**  
Atlantic Tank & Barrel Co.  
Baltimore Co., The  
Pacific Tank & Pipe Co.

**Agitators**  
Dorr Co., The  
General Filtration Co.  
General Machine Co.  
Johnson, John, Co.  
U. S. Stoneware Co.  
Werner & Pfleiderer Co., Inc.

**Air Compressors**  
Ingersoll-Rand Company  
Taylor Instrument Companies  
Worthington Pump & Machinery Corp'n.

**Air Conditioning Apparatus**  
Brauer Air Conditioning Corp.  
Carrier Engineering Corp.  
Drying Systems, Inc.  
Fleisher, W. L., & Co., Inc.

**Air Lift Pumping System**  
Ingersoll-Rand Company  
Schutte & Koerting Co.  
Worthington Pump & Machinery Corp'n.

**Air Repurators**  
See Separators, Air

**Air Washers**  
American Blower Co.  
Brauer Air Conditioning Corp.  
Carrier Engineering Corporation

**Alloys**  
See Ferro-Alloys

**Alloys, Special**  
American Magnesium Corp.  
Lavino, E. J., & Co.  
Metal & Thermit Corp.  
Norton Laboratories  
Shawinigan Electro-Metals Co.

**Aluminum**  
Aluminum Company of America  
Electric Smelt. & Alum. Co.

**Amines**  
Newport Chemical Works, Inc.

**Analytical Apparatus**  
Ainsworth, Wm., & Son  
Bauch & Lomb Opt. Co.  
Braun Corporation, The  
Braun-Knecht-Heimann Co.  
Buffalo Dental Mfg. Co.  
Central Scientific Co.  
Daisger, A., & Co.  
Denver Fire Clay Co.  
Elmer & Amend  
Hoskins Mfg. Co.  
Kaufman-Lattimer Co.  
Laboratory Apparatus Co. (Pittsburgh)

**Analyzers, Gas and Automatic**  
Uehling Instrument Co.  
Williams Apparatus Company

**Asbestos Cloth, Yarn, Banding**  
Tape and Fiber  
Aspomet Company

**Ash Handling Machinery**  
Bartlett & Snow, The C. O., Co.  
Beaumont, R. H., Co.  
Guarantee Construction Co.  
Jeffrey Mfg. Co.

**Assayers**  
See Professional Directors, Pages 376-377

**Autoclaves**  
Buffalo Foundry & Machine Co.  
Devine, J. P., Co.  
Ott, Geo. F., Co.  
Stokes, F. J., Machine Co.  
Valley Iron Works (Williamsport, Pa.)

**Automatic Car Drive Systems**  
Pratt Eng. & Machine Co.

**Automatic Scales**  
American Kron Scale Co.  
Werner & Pfleiderer Co., Inc.

**Automatic Skip Hoist Controllers**  
Cutler-Hammer Mfg. Co.

**Balances and Weights**  
Ainsworth, Wm., & Sons  
American Kron Scale Co.  
Bausch & Lomb Opt. Co.  
Braun Corporation, The  
Braun-Knecht-Heimann Co.  
Central Scientific Co.  
Elmer & Amend  
Gaertner, Wm., & Co.  
Laboratory Supply Co.  
Lens Apparatus Co.  
Mine & Smelter Supply Co.  
Palo Company  
Scientific Materials Co.  
W. M. Welch Manufacturing Co.

**Ball Mills**  
See Mills, Ball, Pebble, Tube

**Barometric Condensers**  
Ingersoll-Rand Company

**Barrels, Steel, Bilge, Agitator and Open Head**  
Detroit Range Boiler Co.

**Baskets, Dipping**  
Newark Wire Cloth Co.

**Bauxite**  
Lavino, E. J., & Co.

**Belt Conveyors**  
Barber-Green Company  
Bartlett & Snow, The C. O., Co.  
Beaumont, R. H., Co.  
Caldwell, H. W., & Son Co.  
Jeffrey Mfg. Co.  
Link-Belt Company  
Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

**Belt Cement**  
Schieren, Chas. A.

**Belt Dressing**  
Schieren, Chas. A.

**Belting, Leather**  
Schieren, Chas. A.

**Belting, Leather (Waterproof)**  
Schieren, Chas. A.

**Belting Link, Leather**  
Schieren, Chas. A.

**Belting, Perforated Leather**  
Schieren, Chas. A.

**Bins, Steel and Concrete**  
Brown Hoisting Machinery Co.  
Beaumont, R. H., Co.

**Bleaching Powder**  
Electro-Bleaching Gas Co.

**Blowers, Fan or Positive Pressure**  
Abb Engineering Co.  
American Blower Co.  
Beach-Russ Company  
Buffalo Forge Co.  
Clarage Fan Co.  
Connersville Blower Co.  
Nash Engineering Co.  
Roots, P. F. & F. M., Co.

**Blowers, Flotation**  
Connersville Blower Co.  
Nash Engineering Co.  
Roots, P. F. & F. M., Co.

**Boiler Coverings**  
Magnesia Association of America

**Boilers, Return Tubular**  
Coatesville Boiler Works

**Boilers, Water Tube**  
Vogt, Henry, Machine Co.

**Bolting Cloths, Silk**  
Abb Engineering Co.  
Abb, Paul O.

**Bone Meal Grinders**  
American Pulverizer Co.

**Books**  
McGraw-Hill Book Company  
Lefax, Inc.

**Books, Loose Leaf**  
Lefax, Inc.

**Brick, Acid Proof**  
Acid-Proof Clay Products Co.  
Chemical Construction Co.  
Crescent Refractories Co.  
General Ceramics Co.  
Harbison-Walker Refractories Co.  
Mine & Smelter Co.  
Brick, Chrome  
Harbison-Walker Refractories Co.

**Brick and Clay, Fire**  
Crescent Refractories Co.  
Fiske Mineral Co.

**Brick Insulating**  
Armstrong Cork & Insulation Co.  
Celite Products Co.

**Brick, Silica**  
Harbison-Walker Refractories Co.  
Bronze, Titanium Aluminum  
Titanium Alloy Mfg. Co., Inc.

**Brushes, Carbon**  
National Carbon Co.  
Speer Carbon Co.

**Buckets, Clamshell & Drag Line**  
Brown Hoisting Machinery Co.

**Bucket Elevators**  
Bartlett & Snow, The C. O., Co.  
Beaumont, R. H., Co.  
Caldwell, H. W., & Son Co.  
Jeffrey Mfg. Co.  
Link-Belt Company  
Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

**Burners**  
Detroit Heating & Lighting Co.

**Burners, Gas and Oil**  
Braun Corporation, The  
Braun-Knecht-Heimann Co.  
Gilbert & Barker Mfg. Co.  
Mine & Smelter Supply Co.  
Monarch Mfg. Works  
Rockwell, W. S., Co.  
Schutte & Koerting Co.

**Burners, Powdered Coal**  
Locomotive Pulverized Fuel Co.  
Powdered Coal Eng. & Eqt. Co.  
Quincy Furnace Spec. Co.

**Burners, Sulphur**  
Glens Falls Machine Co.  
Pratt Eng. & Machine Co.  
Schutte & Koerting Co.  
Valley Iron Wks. (Appleton, Wis.)

**Cabinets, Laboratory**  
Schwartz Sectional System

**Calciners**  
Christie, L. R.

**Calorimeters**  
Central Scientific Co.  
Gaertner, Wm., & Co.  
Sargent, E. H., & Co.  
Schaeffer & Budenberg Mfg. Co.  
Scientific Materials Co.  
Taylor Instrument Companies  
Thomas, Arthur H., Co.

**Carbons, Battery**  
National Carbon Co.  
Speer Carbon Co.

**Carbons, Resistance**  
National Carbon Co.  
Speer Carbon Co.

**Cars, Industrial**  
Easton Car & Construction Co.  
Lakewood Engineering Co.

**Cars, Mine and Ore**  
Lakewood Engineering Co.

**Cascade Basins, Acid Proof**  
Acid Proof Iron Products Co.  
Duriron Casting Co.  
Thermal Syndicate, Ltd., The

**Casseroles**  
Guernsey Earthenware Co.  
Herold China & Pottery Co.  
Royal Copenhagen Porcelain Co.

**Castings, Acid Proof**  
Acid Proof Iron Products Co.  
Bethlehem Fdry. & Mach. Co.  
Brady, James A., Fdry. Co.  
Buffalo Fdry. & Mach. Co.  
Duriron Casting Co.  
Pacific Foundry Co.  
U. S. Cast Iron Pipe & Fdry. Co.

**Castings, Bronze and Brass**  
Titanium Alloy Mfg. Co., The

**Castings, Chemical**  
Acid Proof Iron Products Co.  
Bethlehem Fdry. & Mach. Co.  
Brady, James A., Fdry. Co.  
Buffalo Fdry. & Mach. Co.  
Duriron Casting Co.

**Castings, Iron**  
American Cast Iron Pipe Co.  
Cast Iron Pipe Publicity Bureau

**Castings, Lead**  
Craig Foundry Co.

**Castings, Monel Metal**  
Supplee-Riddle Hdwe. Co.

**Castings, Pure Copper**  
Titanium Alloy Mfg. Co., Inc.

**Castings, Special and Chilled**  
Phoenix Iron Works Co.  
U. S. Cast Iron Pipe & Fdry. Co.

**Caustic Pots**  
See Pots, Cast Iron, Acid Proof

**Caustic Soda and Chlorine Liquid**  
Electro-Bleaching Gas Co.  
Electro Chemical Supply & Eng. Co.

**Bleach Process Co.**  
Pennsylvania Salt Mfg. Co.

**Caustic Soda and Chlorine**  
Electrolytic Cells for Making  
Bleach Process Co.  
Electrolytic Engineering Corp.  
Electron Chemical Co.  
Warner Chemical Co.

**Causticizing Apparatus**  
Dorr Co., The  
Scott, Ernest, & Co.  
Zarembo Co.

**Cement, Acid Proof**  
Anti-Hydro Waterproofing Co.

**Cement Cloth**  
Ludlow-Saylor Wire Co., The

**Cement, Furnace**  
Dixon, Jos., Crucible Co.  
Quincy Furnace Specialties Co.

**Centrifuges**  
Fletcher Works, formerly Schaum & Uhlinger  
Sharples Specialty Co.  
Tolhurst Machine Works  
U. S. & Cuban Allied Engineering Wks.

**Chain Doors**  
Codd, E. J., Co.

**Chemical Apparatus**  
See Acid Eggs, Castings Chemical, Distilling Machinery and Apparatus, Drying Machinery and Apparatus, Enamelled Apparatus, Evaporators, Filter Presses, Glassware, Separators, Centrifugal, Stoneware, etc.

**Chemical Cabinets**  
Schwartz Sectional System

**Chemical Engines**  
American La France Fire Engine Co.

**Chemical Equipment, Ultra Violet Ray**  
R. U. V. Company, The

**Chemical Glassware**  
MacBeth Evans Glass Co.  
Scientific Materials Co.

**Chemical Stoneware**  
See Stoneware, Chemical

**Chemicals**  
Baker, J. T., Chem. Co.  
Barrett Co., The  
Braun Corporation, The  
Braun-Knecht-Heimann Co.  
Daisger, A., & Co.  
Denver Fire Clay Co.  
Elmer & Amend  
General Chemical Co.  
Kaufman-Lattimer Co., The  
Laboratory Apparatus Co. (Pittsburgh)

**Chemicals, Laboratory**  
Lenz Apparatus Co.  
Marden, Orth & Hastings Corp.  
Merck & Co.  
Mine & Smelter Supply Co., The  
Pennsylvania Salt Co.  
Research Laboratory of Chicago  
Roeseler & Hasselacher Chemical Co., The  
Sargent, E. H., & Co.  
Scientific Materials Co.  
Shawinigan Electro-Metals Co.  
Welch, W. M., Mfg. Co.  
Wilkins-Anderson Co.

**Chemists, Manufacturing**  
Baker, J. T., Chem. Co.  
Merck & Co.  
Newport Chemical Works  
Pennsylvania Salt Co.  
Research Laboratory of Chicago  
Roeseler & Hasselacher Chemical Co., The

**Chemists and Chem. Engrs.**  
See also Professional Directory, Pages 376-377

**Chlorine Control Apparatus**  
Wallace & Tiernan Co.

**Chlorinators**  
Wallace & Tiernan Co.

**Chlorine, Liquid**  
See Caustic Soda and Chlorine

**Chrome Ore**  
Lavino, E. J., & Co.

**Classifiers**  
Colorado Iron Works Co.  
Denver Engr'g Works Co., The  
Dorr Co., The  
Worthington Pump & Mach. Corp.

**Clay, Fire**  
Denver Fire Clay Co.

**Clay Goods**  
See Brick and Clay, also Porcelain Ware, also Stoneware, Chemical

**Coal Tar Pitch**  
Barrett Co., The

**Coal Tar Products**  
Newport Chemical Works, Inc.

## WHAT AND WHERE TO BUY

Cocks, Cast Iron, Acid Proof  
See Valves and Cocks, Cast Iron, Acid Proof

Cocks, Stoneware, Acid Proof  
See Valves and Cocks, Stoneware, Acid Proof

Cells, Copper  
Badger, E. B. & Sons Co.  
Swenson Evaporator Co.  
Werner & Pfeiderer Co.  
Zaremba Co.

Cell Pipe  
Whitlock Cell Pipe Co.

Cells & Worms, Stoneware  
See Stoneware, Chemical

Collectors, Dust  
Dust Recovering & Conveying Co.

Color Testing Equipment, Ultra Violet Ray  
R. U. V. Company, The

Combustion Boats  
Engelhard, Chas.

Compressors, Air or Gas  
Crown Mfg. Co.  
General Electric Co.  
Nash Engineering Co.  
Roots, P. F. & F. M.

Concentrating Tables  
Mine & Smelter Supply Co., The

Concrete Hardening Compound (Liquid)  
Anti-Hydro Waterproofing Co.

Condenser, Barometric, Surface or Jet  
Buffalo Fdry. & Mach. Co.  
Connersville Blower Co.  
Devine Co., J. P.  
Lummus, The Walter E. Co.  
Stokes, F. J., Machine Co.  
Worthington Pump & Machinery Corp'n.

Connectors, Frankel Solderless  
Westinghouse Elect. & Mfg. Co.

Controllers, Temperature  
Powers Regulator Co., The

Converters, Rotary  
General Electric Co.  
Lincoln Electric Co., The

Conveying Machinery  
See Machinery, Elevating and Conveying

Conveyors, Pneumatic  
Dust Recovering & Conveying Co.

Conveyors, Portable  
Harber-Greene Company  
Jeffrey Mfg. Co.  
Portable Mach'y Co.

Cooling Cylinders  
Brecht Company, The

Coppersmithing  
Badger, E. B. & Sons Co.  
Lummus, The Walter E. Co.  
Ott, George F., Co.

Cranes and Hoist Controllers  
Cutler-Hammer Mfg. Co.

Cranes  
Brown Hoisting Machinery Co.

Cranes, Locomotive  
Byers, John F., Machine Co.  
Brown Hoisting Mach. Co., The  
Link-Belt Company

Crucibles, Laboratory  
American Platinum Works  
Buffalo Dental Mfg. Co.  
Denver Fire Clay Co.  
Guernsey Earthenware Co.  
Royal Copenhagen Porcelain Co.  
Scientific Materials Co.

Crucibles, Industrial  
Acheson Graphite Co.  
Acid Proof Iron Prod. Co.  
Bartley, Jonathan, Crucible Co.  
Dixon, Jos., Crucible Co.  
Durrion Castings Co.  
Mine & Smelter Supply Co.  
Thermal Syndicate, Ltd., The

Crucibles, Graphite  
Acheson Graphite Co.  
Bartley, Jonathan, Crucible Co.  
Dixon, Jos., Crucible Co.

Crushers, Grinders and Pulverizers  
See Machinery, Crushing, Grinding and Pulverizing

Crushers, Grinders, Pulv., Lab.  
See Machinery, Crushing, Grinding and Pulverizing Laboratory

Crystallizing Disks & Fans, Stoneware  
See Stoneware, Chemical

Crystallizing Fans, Cast Iron  
Buffalo Foundry & Machine Co.  
Devine Co., J. P.  
Pfaudler Company

Cupels  
Denver Fire Clay Co.  
Dixon, Jos., Crucible Co.

Carb Boxes, Meter  
American Cast Iron Pipe Co.

Cast Iron Pipe Publicity Bureau  
Cyanide  
Roessler & Hasslacher Chem. Co.

Cyanide Machinery  
See Machinery, Cyanide

Cyanide Tanks  
Baltimore Co., The

Diaphragms, Acid-Proof  
General Filtration Co.

Die Castings (Bronze)  
Titanium Alloy Mfg. Co., Inc.

Diffusion Batteries  
Blair, Campbell & McLean, Ltd.  
Swenson Evaporator Co.

Directors  
Brecht Company, The  
Elyria Enamelled Products Co.  
Manitowoc Engineering Works

Stuart & Peterson Co.  
Swenson Evaporator Co.

Disintegrators  
Abbe, Paul O.  
Jeffrey Mfg. Co.  
Stedman's Fdry. & Mach. Works

Dissolving Machines  
Lummus, The Walter E. Co.

Distilling Machy. and Apparatus  
Badger, E. B. & Sons Co.  
Blair, Campbell & McLean, Ltd.  
Carbondale Machine Co., The  
Detroit Heating & Lighting Co.  
Devine Co., J. P.  
Durrion Castings Co.  
Elyria Enamelled Products Co.  
Isbell-Porter Co.  
Koven, L. O. & Bro.  
Lummus, The W. E. Co.  
Mott, J. L., Iron Works  
Ott, George F., Co.  
Pfaudler Co., The  
Scientific Materials Co.  
Scott, Ernest, & Co.  
Stevens-Alsworth Co.  
Stokes, F. J., Machine Co.  
Stuart & Peterson Co.  
Swenson Evaporator Co.  
Thomas Co., Arthur H.  
Zaremba Co.

Doors, Chain Screen  
Codd, E. J., Co.

Drop Forge Fittings  
Simmons, John, Company  
Vost, Henry, Machine Co.

Drums, Steel  
Detroit Range Boiler Co.

Dry Blast Plants  
Carrier Engineering Corporation

Dry Cell Filler  
Acheson Graphite Co.

Dryers, Centrifugal  
Elmore, G. H.  
Fletcher Works, formerly Schaum & Uhlinger.  
Sharples Specialty Co.  
Tolhurst Mach. Works  
U. S. & Cuban Allied Eng'g. Wks.

Dryers, Vacuum  
Buffalo Foundry & Machine Co.  
Devine, J. P., Co.  
Jacoby, Hy. E.  
Scott, Ernest, & Co.  
Sowers Mfg. Co.  
Stokes, F. J., Machine Co.

Drying Mach. & Apparatus  
American Blower Co.  
American Process Co.  
Bartlett & Snow, The C. O., Co.  
Bay City Iron Co.  
Brecht Company, The  
Buffalo Foundry & Machine Co.  
Buffalo Forge Co.  
Clarae Fan Co.  
Denver Eng'g Works Co., The  
Devine Co., J. P.  
Drying Systems, Inc.  
Farrar & Trefts, Inc.  
Fleisher, W. L., & Co., Inc.  
Gordon Engineering Corp.  
Kalberty Corporation.  
Koven, L. O. & Bro.  
Manitowoc Engineering Works  
Philadelphia Drying Machy. Co.  
Philadelphia Textile Mach. Co.  
Ruggles-Coles Eng. Co.  
Scott, Ernest, & Co.  
Stearns-Roger Mfg. Co.  
Stokes, F. J., Machine Co.  
Swenson Evaporator Co.  
Vulcan Iron Works

Drying Systems  
Drying Systems, Inc.

Dust Collecting Systems & Engineers  
Dust Recovering & Conveying Co.  
Kalberty Corporation.  
Paxson, J. W., Co.  
Pratt Eng. & Machine Co.  
Raymond Bros. Imp. Pul. Co.  
U. S. Blow Pipe & Dust Collecting Co.  
Williams Patent Crusher & Pulverizer Co.

Dyes and Dye-stuffs  
Marden, Orth & Hastings Corp.

Dynamos, Electroplating  
See Electroplating Dynamoes, Supplies

Dynamoes and Motors  
Bogue, C. J., Elect. Co.  
General Electric Co.  
Jants & Leist Elec. Co.  
Lincoln Electric Co.  
Westinghouse Electric & Mfg. Co.

Electric Cranes  
See Cranes

Electric Furnaces  
See Furnaces, Electric

Electric Furnaces, Laboratory  
See Furnaces, Elec. Lab'y

Electrical Testing Sets  
Weston Electrical Inst. Co.

Electrodes, Carbon  
Acheson Graphite Co.  
National Carbon Co.  
Speer Carbon Co.

Electrolytic Cells  
Bleach Process Co.  
Electro-Chemical Supply & Engineering Co.  
Electrolytic Eng. Corp.  
Electrolytic Oxy-Hydrogen Lab., Inc.  
Electron Chemical Co.  
Warner Chemical Co.

Electrolytic Oxygen and Hydrogen Generators  
Electrolytic Oxy-Hydrogen Lab., Inc.

Electrolytic Salts  
Roessler & Hasslacher Chem. Co.

Electroplating Dynamoes; Supplies  
Bogue, C. J., Elect. Co.  
Jants & Leist Elec. Co.

Elevating and Conveying Machinery  
See Machinery, Conveying and Elevating

Elevators, Revolving Portable Revolver Co.

Enamelled Apparatus, Acid Resisting  
Elyria Enamelled Products Co.  
Mott, J. L., Iron Works  
Pfaudler Co., The  
Stearns-Roger Eng. Co.  
Stuart & Peterson Co.

Engineers, Chemical, Consulting.  
Analytical, Industrial  
Also see Professional Directory, pages 376, 377

Bleach Process Co.  
Cannon-Swenson Co.  
Charlotte Chemical Laboratories, Inc., The  
Dust Recovering & Conveying Co.  
W. L. Fleisher & Co.  
General Machine Co., Inc.  
Hercules Eng. Corp.  
Kalberty Corp., The  
Locomotive Pulverized Fuel Co.  
Powdered Coal Eng. & Equipment Co.  
Pratt Eng. & Machine Co.  
Research Laboratory of Chicago.  
Uehling Instrument Co.  
Williams Apparatus Company

Engineers, Combustion  
Improved Equipment Co.  
Locomotive Pulverized Fuel Co.  
Stearns Eng. Co.  
Uehling Instrument Co.

Engineers' Construction  
Chemical Construction Co.  
Foundation Co.  
Green, Samuel M., Co.  
Guarantee Construction Co.  
Hercules Eng. Corp.  
Research Laboratory of Chicago

Engineers, Furnace  
Hagan, Geo. J., Co.  
Rockwell, W. S., Co.  
Russell Engineering Company

Engineers, Pyrometric  
Hols, Herman A.

Engines, Steam and Gasoline  
Denver Eng'g Works Co., The  
Vulcan Iron Works

Evaporating Disks  
The Acid Proof Clay Products Co.  
Guernsey Earthenware Co.  
Knight, Maurice A.  
Royal Copenhagen Porcelain Co.  
Thermal Syndicate, Ltd., The  
U. S. Stoneware Co.

Evaporators  
Albright-Neil Co., The  
Badger, E. B. & Sons Co.  
Blair, Campbell & McLean, Ltd.  
Brecht Company, The  
Buffalo Fdry. & Mach. Co.  
Devine, J. P., Co.  
Jacoby, Henry E.  
Kestner Evaporator Co.  
Koven, L. O. & Bro.  
Lummus, The W. E. Co.  
Ott, Geo. F., Co.  
Pfaudler Co., The  
Pratt Eng. & Machine Co.  
Scott, Ernest, & Co.  
Sowers Manufacturing Co.  
Sperry, D. H., & Sons  
Stokes, F. J., Machine Co.  
Swenson Evaporator Co.  
Zaremba Co.

Exhausters  
Roots, P. F. & F. M., Co.  
Schutte & Koerting Co.

Extracts  
Marden, Orth & Hastings Corp.

Extractors  
Badger, E. B. & Sons Co.  
Blair, Campbell & McLean, Ltd.  
Devine, J. P., Co.  
Koven, L. O. & Bro.

Lummus, The W. E. Co.  
Ott, Geo. F., Co.

Extractors, Centrifugal  
Fletcher Works, formerly Schaum & Uhlinger  
Sharples Specialty Co.  
Tolhurst Machine Works  
U. S. & Cuban Allied Eng'g. Wks.

Fans  
Buffalo Forge Co.  
Clarae Fan Co.  
Philadelphia Drying Machy. Co.  
Philadelphia Textile Mach. Co.  
Pratt Eng. & Machine Co.  
Raymond Bros. Impact Pulv. Co.  
Schutte & Koerting Co.  
Stearns-Roger Mfg. Co.  
Williams Patent Crusher & Pulv. Co.

Fans, Stoneware, Acid Proof  
General Ceramics Co.  
Knight, Maurice A.  
U. S. Stoneware Co.

Faucets, Stoneware, Acid Proof  
See Stoneware, Chemical

Feeders  
American Pulverizer Co.  
Bartlett & Snow, The C. O., Co.  
Jeffrey Mfg. Co.  
Stephens-Adams Mfg. Co.  
Webster Mfg. Co., The

Felts (Paper Makers)  
Albany Felt Co.  
Huyck F. C., & Sons

Fences, Chain Link  
Anchor Post Iron Works

Fences, Rail  
Anchor Post Iron Works

Fences, Unclimbable, Factory  
Anchor Post Iron Works

Ferro-Alloys  
Continuous Reaction Co., The  
Ferro-Alloy Co., The  
Lavinio, E. J., & Co.  
Leavitt, C. W., & Co.  
Metal & Thermit Corp.  
Standard Alloys Co.  
Titanium Alloy Mfg. Co.

Ferro-carbon—Titanium  
See Titanium

Ferro-Chrome  
Lavinio, E. J., & Co.

Ferro-Manganese  
Lavinio, E. J., & Co.

Ferro-Silicon  
Lavinio, E. J., & Co.

Ferro-Tungsten  
Lavinio, E. J., & Co.

Filing Cabinets  
Schwartz Sectional System

Filing Systems  
Lefax, Inc.

Filter Cloth  
Albany Felt Co.  
Huyck, F. C. & Sons  
Ludlow-Saylor Wire Co., The

Filter Cloth (Metallic)  
Multi-Metal Co., Inc.  
Newark Wire Cloth Co.  
Supple-Biddle Hardware Co.  
Tyler, The W. S., Co.  
United Filters Corp.

Filter Paper  
Angel, H. Reeve, & Co.  
Elmer & Amend  
Laboratory Supply Co., The  
Scientific Materials Co.

Filter, Porous Porcelain  
Herold China & Pottery Co.

Filter Presses  
Albright-Neil Co., The  
American Continuous Filter Co.  
Bay City Iron Co.  
Brecht Company, The  
Burger, Alfred & Co.  
Colorado Iron Works Co.  
Independent Filter Press Co.  
Industrial Filtration Corporation  
Jacoby, Henry E.  
Johnson, John Co.  
Kelly Filter Press Co.  
Koven, L. O. & Bro.  
Lungwitz, E. E.  
Oliver Continuous Filter Co.  
Patterson Fdry. & Mach. Co.  
Perrin, Wm. F., & Co.  
Provest Engineering Co.  
Shriver, T., & Co.  
Sperry, D. H., & Co.  
Sweetland Filter Press Co.

Filter Press Hatt'y Grades  
Swenson Evaporator Co.

Filter Press Parts  
Agitators, Gears, Pumps

Independent Filter Press Co.

Filtration Media  
Celite Products Co.  
Colwell, Lewis  
General Filtration Co.

Filters  
Colwell, Lewis  
Hansford & Terry, Inc.

Filters, Air  
Dust Recovering & Conveying Co.

Filters, Dust  
Dust Recovering & Conveying Co.

Filters, Laboratory  
Perrin, Wm. F., & Co.

Filters, Rotary Continuous  
American Continuous Filter Co.  
Chalmers & Williams  
Colorado Iron Works Co.  
General Filtration Co.  
Industrial Filtration Corp.  
Kelly Filter Press Co.  
Oliver Continuous Filter Co.  
Sweetland Filter Press Co.



**Filters, Suction, Stoneware, Acid Proof**

General Ceramics Co.  
Knight, Maurice A.  
Filters, Vacuum  
General Filtration Co.  
Fire Brick and Clay  
See Brick and Clay, Fire  
Fire Extinguishers  
American-La France Fire Engine Co.

**Fireproof Building Materials**

Aspromet Company  
Floor Gratings

Irving Iron Works  
Flooring

Irving Iron Works  
Flooring, Metallic

Irving Iron Works  
Flooring, Non-Slipping

Irving Iron Works  
Floors & Pits, Acid Resisting

Anti-Hydro Waterproofing Co.  
Flotation Apparatus

Braun Corporation, The  
Braun-Knecht-Heimann Co.

Colorado Iron Works  
Denver Engr's Works Co., The

Roots, P. F. & F. M.  
Fluoropes

Layino, E. J. & Co.  
Forma, Business

Lefax, Inc.  
Foundry Supplies & Equipment

Electric Smelting & Alum. Co.  
Paxson Co., J. W.

Fuel Economiser  
Magnesia Assn. of America

Furnace Cement  
See Cement, Furnace

Furnace Engineers  
See Engineers, Furnace

Furnace Facings & Linings  
Acheson Graphite Co.

Cellite Products Co.  
Dixon, Jos., Crucible Co.

Quigley Furnace Specialties Co.  
Furnace Hoists

Brown Hoisting Machinery Co.  
Furnaces, Assay

Braun Corporation, The  
Braun-Knecht-Heimann Co.

Denver Fire Clay Co.  
Mine & Smelter Supply Co.

Furnaces, Brass and Aluminum  
Melting

Detroit Electric Furnace Co.  
Electric Furnace Co., The

Furnaces, Chloridizing and Sulphat-  
ing

Wedge Mechanical Furnace Co.  
Furnaces, Cupola, Foundry

Worthington Pump & Mach. Corp.  
Furnaces, Doors, Chain

H. J. Codd Co.  
Furnaces, Electric, Lab'y

Brown Instrument Co., The  
Central Scientific Co.

Electric Furnace Co., The  
Electric Htg. Apparatus Co.

Engelhard, Chas.  
Hoskins Mfg. Co.

Scientific Materials Co.  
Furnaces, Heat Treating

Brown Instrument Co., The  
Denver Fire Clay Co.

Detroit Electric Furnace Co.  
Electric Furnace Co., The

Electric Htg. Apparatus Co.  
Engelhard, Chas.

Hagan, Geo. J., Co.  
Hoskins Mfg. Co.

Rockwell, W. S., Co.  
Russell Engineering Co.

Wedge Mechanical Furnace Co.  
Furnaces, Melting

Oil, Gas or Powdered Coal  
Hagan, Geo. J., Co.

Rockwell, W. S., Co.  
Russell Engineering Company

Furnaces, Muffle  
Electric Htg. Apparatus Co.

Hoskins Mfg. Co.  
Improved Equipment Co.

Russell Engineering Company  
Wedge Mechanical Furnace Co.

Furnaces, Roasting and Smelting  
Allis-Chalmers Mfg. Co.

Colorado Iron Works Co.  
Detroit Electric Furnace Co.

General Chemical Co., The  
Pacific Foundry Co.

Russell Engineering Company  
Wedge Mechanical Furnace Co.

Worthington Pump & Machinery  
Corp'n.

Furnaces, Sulphur  
General Chemical Co., The

Kalberry Corp'n.  
Pacific Foundry Co.

Pratt Eng. & Machine Co.  
Wedge Mechanical Furnace Co.

Furniture, Laboratory  
Peterson, Leonard & Co.

Fused Silica  
Thermal Syndicate, Ltd., The

Gas Control Apparatus  
Wallace & Tiernan Co.

Gas Furnaces  
See Furnaces, Gas

Gas Machines  
Detroit Heating & Lighting Co.

Gas Producers  
Chapman Eng. Co.

Finn & Drexler Co.  
Hagan, Geo. J., Co.

Improved Equipment Co.  
Morgan Const. Co.

Smith Gas Engineering Co., The  
Wellman-Seaver-Morgan Co.

One Pumps and Exhaustors  
See Pumps, Gas, Liquid or

Vacuum  
Gas Scrubbers and Washers

Buffalo Forge Co.  
Gaskets

Sarco Company, Inc.  
Gaskets, Acid-Resisting

Crane Packing Co.  
Gates, Iron & Wire

Anchor Post Iron Works  
Gauges, Recording, Indicating,

Draft, Pressure  
Bristol Co., The

Brown Instrument Co.  
Foxboro Co.

Pneumercator Co., Inc.  
Schaeffer & Budenburg Mfg. Co.

Taylor Instrument Companies  
Thwing Instrument Co.

Uehling Instrument Co.  
Gears

Caldwell, H. W., & Son Co.  
Generators

See Dynamos and Motors  
Generators (Oxygen and Hydrogen)

Electrolytic Oxy-Hydrogen Lab.,  
Inc.

Glass Blowing  
Central Scientific Co.

Denver Fire Clay Co.  
International Glass Co.

Kauffman-Lattimer Co., The  
Laboratory Supply Co.

Lens Apparatus Co.  
Scientific Materials Co.

Glassware, Chemical  
Flasks, Breakers, Crystallizing

Dishes, Hydrometer Jars, Petri  
Dishes, etc.

Central Scientific Co.  
Eimer & Amend

Griebel, Instrument Co.  
International Glass Co., The

Kauffman-Lattimer Co., The  
Laboratory Supply Co.

**WHAT AND WHERE TO BUY**

Morgan Const. Co.  
Smith Gas Engineering Co., The  
Wellman-Seaver-Morgan Co.

One Pumps and Exhaustors  
See Pumps, Gas, Liquid or  
Vacuum

Gas Scrubbers and Washers  
Buffalo Forge Co.

Gaskets  
Sarco Company, Inc.

Gaskets, Acid-Resisting  
Crane Packing Co.

Gates, Iron & Wire  
Anchor Post Iron Works

Gauges, Recording, Indicating,  
Draft, Pressure

Bristol Co., The  
Brown Instrument Co.

Foxboro Co.  
Pneumercator Co., Inc.

Schaeffer & Budenburg Mfg. Co.  
Taylor Instrument Companies

Thwing Instrument Co.  
Uehling Instrument Co.

Gears  
Caldwell, H. W., & Son Co.

Generators  
See Dynamos and Motors

Generators (Oxygen and Hydrogen)  
Electrolytic Oxy-Hydrogen Lab.,

Inc.  
Glass Blowing

Central Scientific Co.  
Denver Fire Clay Co.

International Glass Co.  
Kauffman-Lattimer Co., The

Laboratory Supply Co.  
Lens Apparatus Co.

Scientific Materials Co.  
Glassware, Chemical

Flasks, Breakers, Crystallizing  
Dishes, Hydrometer Jars, Petri

Dishes, etc.  
Central Scientific Co.

Eimer & Amend  
Griebel, Instrument Co.

International Glass Co., The  
Kauffman-Lattimer Co., The

Laboratory Supply Co.  
Macbeth-Evans Glass Co., The

Mine & Smelter Supply Co., The  
Glassware, Quartz

Hanovia Chemical & Mfg. Co.  
Glazing Construction

Aspromet Company  
Graphite

Acheson Graphite Co.  
Gratings

Irving Iron Works  
Grating, Subway

Irving Iron Works  
Grinders

See Machinery, Crushing, Grind-  
ing and Pulverizing

Hardness Testers  
Hols, Herman A.

Heat Insulation  
Magnesia Assn. of America

Heaters, Feed Water  
Braemer Air Conditioning Corp.

Heaters, Noiseless  
Schutte & Koertling Co.

Heating Apparatus and Systems  
American Blower Co.

Braemer Air Conditioning Co.  
Buffalo Forge Co.

Clarage Fan Co.  
Powers Regulator Co., The

Ruggles-Coles Eng. Co.  
Sarco Co., Inc.

Heating Regulators  
Powers Regulator Co., The

Holts  
Brown Hoisting Machinery Co.

Denver Engr's Works Co., The  
Hydraulic Leather

Schieren, Chas. A.  
Hydraulic Machinery

Hydraulic Press Mfg. Co., The  
Hydraulic Presses

Hydraulic Press Mfg. Co., The  
Philadelphia Drying Mach'y Co.

Hydrogen Generating Apparatus  
Electrolytic Oxy-Hydrogen Lab.,

Inc.  
Improved Equipment Co.

Hydrometers  
Brown Instrument Co., The

Griebel Instrument Co.  
Impregnating Apparatus

Devine, J. P., Co.  
Instruments, Electrical and Testing

Bristol Co., The  
Brown Instrument Co.

Central Scientific Co.  
Eimer & Amend

Hoskins Mfg. Co.  
Precision Ther. & Inst. Co.

Pyroelectric Instrument Co.  
Schaeffer & Budenburg Mfg. Co.

Shore Instrument Co.  
Stupakoff Laboratories

Thwing Instrument Co.  
Uehling Instrument Co.

W. M. Welch Manufacturing Co.  
Westinghouse Electric & Mfg. Co.

Weston Electrical Instrument Co.  
Insulating Material, Electric

Redmanol Chemical Products Co.  
Insulating Material, Heat

Armstrong Cork & Insulation Co.  
Celite Products Co.

General Bakelite Co.  
Magnesia Association of America

Intermediates  
Marden, Orth & Hastings Corp.

Newport Chemical Works, Inc.  
Iron and Steel Corrugated

Aspromet Company  
Jackets (Paper Makers)

Albany Felt Co.  
F. C. Hyck & Sons.

Jigs  
Denver Engr's Works Co., The

Worthington Pump & Mch. Corp.  
Kettles, Cast Iron Acid Proof

Acid Proof Iron Products Co.  
Bethlehem Fdry. & Mach. Co.

Buffalo Fdry. & Machine Co.  
Devine, J. P., Co.

Duriron Castings Co.  
Farrar & Trefts.

Pacific Foundry Co.  
Sowers Manufacturing Co.

Stevens-Aylsworth Company  
U. S. Cast Iron Pipe & Fdry. Co.

Kettles, Enamelled, Acid Proof  
Elvria Enamelled Products Co.

Mott, J. L., Iron Works  
Pfaudler Co., The

Stuart & Peterson Co.  
Kettles, Steam Jacketed

Buffalo Fdry. & Machine Co.  
Detroit Heating & Lighting Co.

Devine Co., J. P.  
Duriron Castings Co.

Elvria Enamelled Products Co.  
Koven, L. O., & Bro.

Lummus, The Walter E., Co.  
Mott, J. L., Iron Works

Oil, George F., Co.  
Pfaudler Company, The

Pratt Eng. & Machine Co.  
Stuart & Peterson Co.

Kettles, Stoneware, Acid Proof  
See Stoneware, Chemical

Kiln, Lime  
Improved Equipment Co.

Vulcan Iron Works  
Kiln, Rotary & Nodulizing

American Process Co.  
Colwell, Lewis

Ruggles-Coles Eng. Co.  
Vulcan Iron Works

Laboratory Apparatus and Supplies  
Bausch & Lomb Optical Co.

Braun Corporation, The  
Braun-Knecht-Heimann Co.

Buffalo Dental Mfg. Co.  
Central Scientific Co.

Daigler, A., & Co.  
Detroit Heating & Lighting Co.

Eimer & Amend  
Gaertner, Wm., & Co.

Guernsey Earthenware Co.  
Hoskins Mfg. Co.

International Glass Co.  
Kauffman-Lattimer Co., The

Laboratory Apparatus Co. (Pitts-  
burgh).

Lenz Apparatus Co.  
Mine & Smelter Supply Co., The

Multi-Metal Separating Screen Co.  
Palo Company

Peterson, Leonard & Co.  
Pyroelectric Instrument Co.

Royal Copenhagen Porcelain Co.  
Sargent, E. H., & Co.

Scientific Materials Co.  
Thomas Co., Arthur H.

Welch, W. M., Mfg. Co.  
Werner & Pfleiderer Co., Inc.

Wilkins-Anderson Co.  
Lacing Leather

Schieren, Chas. A.  
Lamp, Arc, & Incandescent, Tung-  
sten

Hols, H. A.  
Leaded Zinc Oxide

New Jersey Zinc Company, The  
Lifting Magnets

Cutler-Hammer Mfg. Co.  
Lifts, Air Jet

Bethlehem Fdry. & Mach. Co.  
Lummus, The Walter E., Co.

Liquid Ammonia Plants.  
Lummus, The Walter E., Co.

Lithopons  
New Jersey Zinc Company, The

Loaders, Bucket  
Barber-Greene Company

Loaders, Pneumatic  
Dust Recovering & Conveying Co.

Locomotive Cranes  
Brown Hoisting Machinery Co.

**Locomotives, Industrial**

Fate, J. D. Co.  
Jeffrey Mfg. Co.  
Lakewood Engineering Co.  
Vulcan Iron Works

**Machinery, Agitating**

Abbé, Paul O.  
Dorr Co., The

Gedge-Gray Co., The  
Johnson, John, Co.

Stokes, F. J., Machine Co.  
Machinery, Automatic Weighing

American Kren Scale Co.  
Schaeffer Eng. & Equipment Co.

Machinery, Bleach Powder  
Beach Process Co.

Machinery, Classifying  
Denver Engr's Works Co., The

Dorr Co., The  
Machinery, Coal Grinding

Abbé, Paul O.  
Aero Pulverizer Co.

American Pulverizer Co.  
Jeffrey Mfg. Co.

Powdered Coal Eng. & Equip. Co.  
Pratt Eng. & Machine Co.

Raymond Bros. Imp. Pulv. Co.  
Williams Patent Crusher & Pulv.

Co.  
Machinery, Conveying & Elevating

Bartlett & Snow, The C. O., Co.  
Beaumont, R. H., Co.

Caldwell, H. W., & Son Co.  
Dust Recovering & Conveying Co.

Guarantee Construction Co.  
Jeffrey Mfg. Co.

Link-Belt Company  
Monarch Mfg. Works

Portable Mach'y Co.  
Robins Conveying Belt Co.

Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

Machinery, Crushing, Grinding and  
Pulverizing

Abbé Eng's Co.  
Abbé, Paul O.

Aero Pulverizer Co.  
Allis-Chalmers Mfg. Co.

American Pulverizer Co.  
Bartlett & Snow, The C. O., Co.

Bradley Pulverizer Co.  
Buchanan, C. G., & Co.

Chalmers & Williams  
Colorado Iron Works Co., The

Denver Engr's Works Co., The  
Jeffrey Mfg. Co.

K-B Pulverizer Co.  
Kent Mill Co.

Mead & Company  
Mine & Smelter Supply Co.

Patterson Fdy. & Mach. Co.  
Pratt Eng. & Machine Co.

Raymond Bros. Imp. Pulv. Co.  
Stedman's Foundry & Mach. Wks.

Sturtevant Mill Co.  
Vulcan Iron Works

Williams Patent Crusher & Pul-  
verizer Co.

Worthington Pump & Mch. Corp.  
Machinery, Crushing, Grinding &

Pulverizing Lab'y  
Abbé, Eng's Co.

Abbé, Paul O.  
Braun Corporation, The

Braun-Knecht-Heimann Co.  
Central Scientific Co.

Chalmers & Williams  
Denver Engr's Works Co., The

Jeffrey Mfg. Co.  
Scientific Materials Co.

## WHAT AND WHERE TO BUY

**Farrar & Trefts.**  
Gedge-Gray Co., The  
Mead & Company  
Patterson Fdy. & Mach. Co.  
Pratt Eng. & Machine Co.  
Sowers Manufacturing Co.  
Stokes, F. J., Machine Co.

**Machinery, Ore and Coal Handling**  
Barber-Greene Company  
Bartlett & Snow, The C. O., Co.  
Brown Hoisting Machinery Co.  
Guarantee Construction Co.  
Jeffrey Mfg. Co.  
Link-Belt Company  
Roots, P. F. & F. M., Co.  
Stephens-Adamson Mfg. Co.

**Machinery, Ore Concentrating**  
Allis-Chalmers Mfg. Co.  
Chalmers & Williams  
Colorado Iron Works  
Denver Engr's Works Co., The  
Dorr Co., The  
Kent Mill Co.  
Ruggles-Coles Eng. Co.  
Mine and Smelter Supply Co.  
Worthington Pump & Mch. Corp.

**Machinery, Pipe Bending**  
American Pipe Bending Mach. Co.

**Machinery, Refrigerating**  
Brecht Company, The  
Carbondale Machine Co., The  
Vort, Henry, Machine Co.

**Machinery, Screening**  
Allis-Chalmers Mfg. Co.  
Bartlett & Snow, The C. O., Co.  
Chalmers & Williams  
Dull, Raymond W., Co.  
Jeffrey Mfg. Co.  
Link-Belt Company  
Stephens-Adamson Mfg. Co.  
Tyler, The W. S., Co.  
Webster Mfg. Co., The  
Worthington Pump & Mch. Corp.

**Machinery, Soap**  
Gedge-Gray Co., The

**Machinery, Special**  
Albright-Neil Co., The  
Brecht Company, The  
Buffalo Fdy. & Machine Co.  
Denver Engr's Works Co., The  
Phoenix Iron Works Co.  
Ruggles-Coles Eng. Co.  
Stevens-Ayleworth Co.  
Stokes, F. J., Machine Co.

**Machinery, Thickening and Dewatering**  
Denver Engr's Works Co., The  
Dorr Co., The

**Machinery, Transmission**  
Caldwell H. W., & Son Co.  
Jeffrey Mfg. Co.  
Stephens-Adamson Mfg. Co.  
Webster Mfg. Co., The

**Machinery, Weighing**  
Schaffer Eng. & Equipment Co.  
Sturtevant Mill Co.

**Magnesite**  
Foots Mineral Co.  
Harbison-Walker Refractories Co.

**Magnetic Clutches**  
Cutler-Hammer Mfg. Co.

**Magnetic Disc Brakes (Direct Current)**  
Cutler-Hammer Mfg. Co.

**Magnesium Metal**  
American Magnesium Corp.  
Leavitt, C. W., & Co.  
Norton Laboratories  
Shawinigan Electro-Metals Co.

**Magnesium Ribbon**  
Daigger, A., & Co.

**Magnetic Pulleys**  
Dings Magnetic Separator Co.  
Magnetic Mfg. Co.

**Magnets**  
Dings Magnetic Separator Co.  
Magnetic Mfg. Co.

**Magnets, Lifting**  
Cutler-Hammer Mfg. Co.

**Manganese Ore**  
Lavino, E. J., & Co.

**Metal, Asbestos Protected**  
Aspromet Company

**Metallographic Apparatus**  
Hols, Herman A.  
Scientific Materials Co.

**Metallo-Radiographic Apparatus**  
Hols, Herman A.

**Metallurgical Engineers**  
*See Professional Directory, Pages 376-377*

**Metallurgical Processes**  
Door Co., The  
Dwight & Lloyd Sintering Co.

**Metals**  
Electric Smelting & Alum. Co.  
Ferro Alloy Co., The  
Lavino, E. J., & Co.  
Leavitt, C. W., & Co.  
Metals Disintegrating Co.  
Metal & Thermit Corp.  
Shawinigan Electro-Metals Co.

**Meter Box Covers**  
American Cast Iron Pipe Co.  
Cast Iron Pipe Publicity Bureau

**Meters, Flow, Air, Gas, Water**  
Spray Engineering Co.

**Microscopes**  
Bausch & Lomb Opt. Co.  
Central Scientific Co.  
Scientific Materials Co.  
Thomas Co., Arthur H.

**Mills, Ball, Pebble and Tube**  
Abbe, Eng's Co.  
Abbe, Paul O.  
Allis-Chalmers Mfg. Co.  
Chalmers & Williams  
Colorado Iron Works Co.  
Denver Engr's Works Co., The  
Mead & Company  
Mine & Smelter Supply Co., The  
Patterson Fdy. & Mach. Co.  
Stokes, F. J., Machine Co.  
Worthington Pump & Machinery Corp'n.

**Mills, Emery**  
Sturtevant Mill Co.

**Mills, Hammer**  
Abbe, Paul O.

**Minerals and Ores**  
American Magnesium Corp.  
Continuous Reaction Co., The  
Foots Mineral Co.  
Lavino, E. J., & Co.  
Leavitt, C. W., & Co.  
Shawinigan Electro-Metals Co.  
Vanadium Alloys Steel Co.

**Mixers, Acidulating**  
Pratt Eng. & Mach. Co.

**Mixers, Batch**  
Abbe, Paul O.  
Gedge-Gray Co., The  
Pratt Eng. & Mach. Co.  
Werner & Pfleiderer Co., Inc.

**Molybdenum Ore**  
Foots Mineral Co.

**Mund Metal**  
Multi-Metal Co., Inc.  
Supplee-Biddle Hdw. Co.

**Monteius**  
*See Acid Eggs, Cast Iron, also Stoneware*

**Motors, Electric**  
Lincoln Electric Co., The

**Motor Speed Regulators**  
Cutler-Hammer Mfg. Co.

**Motor Starters**  
Cutler-Hammer Mfg. Co.

**Muffles**  
Denver Fire Clay Co.  
Mine & Smelter Supply Co., The  
Russell Engineering Company

**Nitro Compounds**  
Newport Chemical Works, Inc.

**Nozzles, Spray**  
American Blower Co.  
Buffalo Forge Co.  
Carrier Engineering Corporation  
Duriron Castings Co.  
Schutte & Koerting Co.  
Spray Engineering Co.  
Star Brass Works, The

**Nozzles & Jets, Stoneware**  
*See Stoneware, Chemical*

**Oils, Flotation**  
*See Flotation Oil*

**Oil & Grease Extraction Equipment**  
Bartlett & Snow, The C. O., Co.

**Ore Bedding and Reclaiming Systems**  
Robbins Conveying Belt Co.

**Ores**  
*See Minerals and Ores*

**Ovens, Laboratory**  
Central Scientific Co.

**Oxide, Gas Purifying**  
Lavino, E. J., & Co.

**Oxygen or Hydrogen Generating Equipment**  
Electrolytic Oxy-Hydrogen Lab., Inc.

**International Oxygen Co.**

**Packing**  
Crane Packing Co.

**Packing, Acid-Resisting**  
Crane Packing Co.

**Packing, Flexible Metallic**  
Crane Packing Co.

**Packing, Hydraulic**  
Crane Packing Co.

**Schieren, Chas. A.**

**Paint, Pigment, Graphite**  
Acheson Graphite Co.

**Paint, Acid Proof and Technical**  
Toch Bros.

**Pans, Vacuum**  
Badger, E. B., & Sons Co.  
Blair, Campbell & McLean, Ltd.

**Buffalo Fdy. & Mach. Co.**

**Detroit Heating & Lighting Co.**

**Devine, J. P., Co.**

**Kestner Evaporator Co.**

**Koven, L. O., & Bro.**

**Lummus, Th. W. E., Co.**

**Pfandler Company, The**

**Pratt Eng. & Machine Co.**

**Scott, Ernest, & Co.**

**Sowers Manufacturing Co.**

**Stokes, F. J., Machine Co.**

**Swenson Evaporator Co.**

**Zarembo Co.**

**Patent Attorneys**  
*See Professional Directory, Pages 376-377*

**Pebble Mills**  
*See Mills, Ball, Pebble and Tube*

**Perforated Metal**  
Mundt, Chas., & Sons

**Photomicrographic Apparatus**  
Bausch & Lomb Opt. Co.

**Pipe, Cast Iron**  
Brady Fdy. Co., James A.

**Cast Iron Pipe Publicity Bureau**

**Clow, James B., & Sons**

**Donaldson Iron Co.**

**Glymorglan Pipe & Foundry Co.**

**Lynchburg Foundry Co.**

**Massillon Iron & Steel Co.**

**U. S. Cast Iron Pipe & Fdy. Co.**

**Warren Foundry & Machine Co.**

**Pipe, Silica Ware**  
Thermal Syndicate, Ltd., The

**Pipe and Roller Covering**  
Magnesia Association of America

**Pipe & Fittings, Cast Iron, Acid Proof**  
Acid Proof Iron Products Co.

**Duriron Castings Co.**

**Pacific Foundry Co.**

**Pipe & Fittings, Copper**  
Badger, E. B., & Sons Co.

**Lummus, Walter E., Co., The**

**Ott, George F., Co.**

**Pipe & Fittings, Enameled, Acid Proof**  
Elyria Enameled Products Co.

**Pfaudler Co., The**

**Stuart & Peterson Co.**

**Pipe & Fittings, Lead, Tin or Silver Lined**  
Badger, E. B., & Sons Co.

**Cleveland Brass Mfg. Co.**

**Lead Lined Iron Pipe Co.**

**United Lined Tube & Valve Co.**

**Pipe & Fittings, Stoneware, Acid Proof**  
The Acid Proof Clay Products Co.

**General Ceramics Co.**

**Graham, C., Chem. Pottery Wks.**

**Knight, Maurice A.**

**U. S. Stoneware Co.**

**Pipe & Fittings, Wood**  
National Tank & Pipe Co.

**Pacific Tank & Pipe Co.**

**Pitch, Coal Tar**  
Barrett Co., The

**Platinum Wire, Sheet and Foil; Crucibles, Dishes, Electrodes Laboratory Ware, all kinds**  
American Platinum Works

**Baker & Co., Inc.**

**Bishop, J., & Co., Platinum Wks.**

**Scientific Materials Co.**

**Thomas Co., Arthur H.**

**Plug Cocks**  
*See Valves and Cocks*

**Pneumatic Tools**  
Ingersoll-Rand Company

**Pneumercator**  
Pneumercator Co.

**Porcelain Ware**  
Bausch & Lomb Opt. Co.

**Braun Corporation, The**

**Braun-Knecht-Heinmann Co.**

**Central Scientific Co.**

**Guernsey Earthenware Co.**

**Herold China & Pottery Co.**

**Mine & Smelter Supply Co., The**

**The Royal Copenhagen Porcelain Co.**

**Portable Conveyors**  
Barber-Greene Company

**Portable Machinery Co.**

**Pots, Cast Iron, Acid Proof**  
Acid Proof Iron Products Co.

**Bethlehem Foundry & Mach. Co.**

**Buffalo Foundry & Machine Co.**

**Duriron Castings Co.**

**Pratt Eng. & Mach. Co.**

**U. S. Cast Iron Pipe & Fdy. Co.**

**Pots, Stoneware, Acid Proof**  
*See Stoneware, Chemical*

**Powdered Coal Equipment**  
Dust Recovering & Conveying Co.

**Locomotive Pulverized Fuel Co.**

**Powdered Coal Eng. & Eumpt. Co.**

**Raymond Bros. Impact Pul. Co.**

**Standard Mechanical Equipment Co.**

**Precipitators, Centrifugal**  
Fletcher Works, formerly Schaum

**Uhlinger**

**Presses, Hydraulic**  
Hydraulic Press Mfg. Co., The

**Perrin, Wm. R., & Co.**

**Producers, Gas**  
Steers Eng. Co.

**Pulleys, Magnetic**  
Dings Magnetic Separator Co.

**Pulverizers, Hammer Mill**  
American Pulverizer Co.

**Bartlett & Snow, The C. O., Co.**

**K-B Pulverizer Co.**

**Pulverizers, Laboratory**  
*See Machinery, Crushing, Grinding and Pulverizing, Laboratory*

**Pulverizing Machinery**  
*See Machinery, Crushing, Grinding and Pulverizing*

**Pump Controllers**  
Cutler-Hammer Mfg. Co.

**Pumps, Acid or Acid Gases**  
Abbe Eng's Co.

**Duriron Castings Co.**

**Elmore, G. H.**

**Lummus, The Walter E., Co.**

**Monarch Mfg. Works**

**Nash Engineering Co.**

**Roots, P. F. & F. M.**

**Taber Pump Co.**

**United Lined Tube & Valve Co.**

**Worthington Pump & Mch. Corp.**

**Pumps, Centrifugal**  
Abbe Eng's Co.

**Chemical Equipment Co.**

**Duriron Casting Co.**

**Elmore, G. H.**

**Ingersoll-Rand Company**

**Monarch Mfg. Works**

**Schutte & Koerting Co.**

**Taber Pump Co.**

**Worthington Pump & Mch. Corp.**

**Pumps, Diaphragms**  
Dorr Co., The

**Johnson, John, Co.**

**Pumps, Gas, Liquid or Vacuum**  
Beach-Russ Co.

**Crowell Mfg. Co.**

**Roots, P. F. & F. M., Co.**

**Pumps, Sand**  
Krogh Pump Mfg. Co.

**Pumps, Stoneware, Acid Proof**  
General Ceramics Co.

**Knight, M. A.**

**U. S. Stoneware Co.**

**Fryites**  
Lavino, E. J., & Co.

**Fryometers**  
Braun Corporation, The

**Braun-Knecht-Heinmann Co.**

**Brown Instrument Co.**

**Bristol Co., The**

**Central Scientific Co.**

**Engelhard, Chas.**

**Hols, Herman A.**

**Hoskins Mfg. Co.**

**Palo Company**

**Pyroelectric Instrument Co.**

**Sargent, E. T., & Co.**

**Schaeffer & Budenburg Mfg. Co.**

**Scientific Materials Co.**

**Shore Instrument Co.**

**Stupakoff Laboratories**

**Taylor Instrument Companies**

**Thomas Co., Arthur H.**

**Thwing Instrument Co.**

**Uehling Instrument Co.**

**Wilson-Maculen Co.**

**Pyrometer Installations**  
Hols, Herman A.

**Stupakoff Laboratories**

**Pyrometer Protection Tubes**  
Engelhard, Chas.

**Herold China & Pottery Co.**

**Stupakoff Laboratories**

**Thermal Syndicate, Ltd., The**

**Pyrometer Sheets, Graphite**  
Acheson Graphite Co.

**Pyroscopes**  
Shore Instrument Co.

**Quartz Glass**  
*See also Fused Silica*

**Engelhard, Chas.**

**Thermal Syndicate, Ltd., The**

**Railings, Iron**  
Anchor Post Iron Works

**Railways, Industrial & Portable**  
Easton Car & Construction Co.

**Lakewood Engineering Co.**

**Rawhide Rope**  
Schieren, Chas. A.

**Re-Agent Cabinets**  
Schwartz Sectional System

**Recorders, CO<sub>2</sub>**  
Uehling Instrument Co.

**Recording Instruments, Pressure, Temperature, Electricity, Motion, Speed, Time**  
Bristol Co., The

**Brown Instrument Co.**

**Hols, Herman A.**

**Engelhard, Chas.**

**Hoskins Mfg. Co.**

**Precision Therm. & Inst. Co.**

**Pyroelectric Instrument Co.**

**Schaeffer & Budenburg Mfg. Co.**

**Taylor Instrument Companies**

**Thwing Instrument Co.**

**Uehling Instrument Co.**

**Wilson-Maculen Co.**

**Refractories**  
*See Brick and Clay, Fire*

**Refrigerating Machinery**  
*See Machinery, Refrigerating*

**Regulators, Automatic Humidity**  
American Blower Co.

**Carrier Engineering Corp.**



## Retorts

See Acid Distillation Apparatus

## Retorts, Graphite

Bartley, Jonathan, Cruc. Co.

## Retorts, Vertical

Lambert-Porter Co.

## Rheostats

Central Scientific Co.

## Rods

W. S. Hough, Jr., Co.

## Rolls, Crushing

American Pulverizer Co.

Buchanan, C. G., Co., Inc.

Jeffrey Mfr. Co.

Worthington Pump &amp; Machinery Corp'n.

## Roofs, Walls, Partitions, etc., Concrete

Aspromet Company

## Roofings and Sidings—Fume Proof

Aspromet Company

Brown Hoisting Machinery Co.

## Safety Devices

American La France Fire Engine Co.

## Safety Goggles

American La France Fire Engine Co.

## Sample Cabinets

Schwartz Sectional System

## Second Hand Equipment

See Searchlight Section, pages 378-385

## Acme Glass Wool Works

Brooklyn Paper Mills

Burns &amp; Roberts

Consolidated Products Co.

Genesee Chemical Co.

Goldsmith Bros., S. &amp; B. Co.

McCoy Brandt Machy. Co.

Machinery Utilities Co.

Moore Lime Co.

Morse Bros. Mach. &amp; Supply Co.

Payne, Howard B.

Perry, Buxton, Doane Co.

Stewart, Paul &amp; Co.

Youngstown Welding Co.

Zelnicke, Walter A., Supply Co.

## Scales, Conveyor

American Kron Scale Co.

Schaffer Eng. &amp; Equip. Co.

## Scales, Weighing

American Kron Scale Co.

Sturtevant Mill Co.

## Scleroscope

Hols, Herman A.

Shore Instrument Co.

## Screens

Abbe, Paul O.

Bartlett &amp; Snow, The C. O. Co.

Caldwell, H. W., &amp; Son Co.

Colorado Iron Works Co.

Kent Mill Co.

Multi-Metal Separating Screen Co.

Mundt, Chas., &amp; Co.

Newark Wire Cloth Co.

Patterson, Fdy. &amp; Mach. Co.

Sturtevant Mill Co.

## Screens, Chain

Codd, E. J., Co.

## Screens or Cloth, Fertilizer

Ludlow-Saylor Wire Co., The

## Screens, Mining

Ludlow-Saylor Wire Co., The

## Screens, Wire, Brass, Copper, Steel, etc.

Ludlow-Saylor Wire Co., The

Multi-Metal Co., Inc.

Tyler, The W. S., Co.

## Screening Machinery

See Machinery, Screening

## Separators, Air

Aero Pulverizer Co.

Pratt Eng. &amp; Machine Co.

Raymond Bros. Imp. Pulv. Co.

Williams Patent Crusher &amp; Pulverizer Co.

## Separators, Centrifugal

Fletcher Works, formerly Schaub &amp; Uhlinger

Sharples Specialty Co.

Tolhurst Mach. Works.

## Separators, Electrostatic

Huff Electrostatic Separator Co.

## Separators, Inclined Vibrating

Screens

Tyler, The W. S., Co.

## Separators, Magnetic

Buchanan, C. G., Co.

Cutter-Hammer Mfg. Co.

Dings-Magnetic Separator Co.

Magnetic Mfg. Co.

Paxon, J. W., Co.

## Separators, Steam and Oil

Braemer Air Conditioning Corp.

## Sieves, Laboratory

Multi-Metal Co., Inc.

Newark Wire Cloth Co.

## Sintering

Link-Belt Company

Silo, Wood

National Tank &amp; Pipe Co.

Pacific Tank &amp; Pipe Co.

## Sintering Processes

Dwight &amp; Lloyd Sintering Co.

## Solderless Connectors, Frankal

Westinghouse Elec. &amp; Mfg. Co.

## Solvent Recovery Apparatus

Lummus, The Walter E., Co.

## Specimen Cabinets

Schwartz Sectional System

Spelter, Spiegelstein

New Jersey Zinc Company, The

## Spiegelstein

Lavinio, E. J., &amp; Co.

## Spray Nozzles

See Nozzles, Spray

## WHAT AND WHERE TO BUY

## Sprocket Wheels

Caldwell H. W., &amp; Son Co.

Link-Belt Company

Steel, High Speed

Standard Alloys Co.

## Steel Plate Construction

Sharpsville Boiler Works

Coatesville Boiler Works

Sterilizing Equipment, Water

Wallace &amp; Tiernan Co.

Sterilizers, Ultra Violet Ray

R. U. V. Company, The

Still, Chemical

See Distilling Machinery and Apparatus

## Stirrers, Acid Proof

Acheson Graphite Co.

Acid Proof Iron Products Co.

Duriron Castings Co.

## Stokers

Hagan, Geo. J., Co.

## Stoneware, Chemical, consisting of

Bottles, Carboy Stoppers, Coils

and Worms, Crystallizing Dishes,

Chlorine Generators, Decanting

Pots, Dippers, Digging Dishes,

Faucets, Funnels, Kettles, Mortars

and Pestles, Nozzles and Jets,

Pots and Jars, Pitchers, Retorts,

Receivers or Wouff Bottles, Sinks, Storage Jars, etc.

Acid-Proof Clay Products Co.

General Ceramics Co.

Graham, C., Chem. Pot'y Wks.

Knight, Maurice A.

Monarch Mfg. Works

U. S. Stoneware Co.

Weeks, A. J.

## Stopper Heads

Bartley, Jonathan, Crucible Co.

## Subway Grating

Irving Iron Works

## Sulphur Burners

See Burners, Sulphur

## Sulphur, Crude

Union Sulphur Co., The

## Sulphur Dioxide, Liquid

Ansul Chemical Co.

## Sulphuric Acid Plants

Electro Chemical Supply &amp; Engineering Co.

Chemical Const. Co.

Kalberry Corp., The

Supplies, Mill and Mine

Colonial Supply Co.

## Switchboards

Electro-Chemical Supply &amp; Engineering Co.

## Tanks, Acid

Westinghouse Electric &amp; Mfg. Co.

## Tanks, Acid Proof

Knight, Maurice A.

U. S. Stoneware Co.

## Tanks, Enamelled, Acid Proof

Elyria Enamelled Products Co.

Pfauder Co., The

Stuart &amp; Peterson Co.

## Tanks, Heating Regulators

Powers Regulator Co., The

## Tanks, Lead Lined, Acid Proof

Acme Tank Co.

Blair, Campbell &amp; McLean, Ltd.

Dunk Tank Works

Eagle Tank Co.

Hauser-Stander Tank Co.

Johnson &amp; Carlson

United Lined Tube &amp; Valve Co.

Wendnagel Co.

## Tanks, Oil

Coatesville Boiler Works

Sharpsville Boiler Works

## Tanks, Steel

Brecht Company, The

Coatesville Boiler Works

Codd, E. J., Company

Detroit Range Boiler Co.

Hamburg Boiler Works

Kellogg, The M. W. Co.

Koven, L. O., &amp; Bro.

Manitowoc Engineering Works

Phoenix Iron Works Co.

Sharpsville Boiler Works

Stevens-Aylsworth Co.

Stevens Brothers

## Tanks, Stoneware, Acid Proof

General Ceramics Co.

Graham, C., Chem. Pot'y Works

Knight, Maurice A.

U. S. Stoneware Co.

## Tanks, Wood

Acme Tank Co.

Atlantic Tank &amp; Barrel Co.

Baltimore Co., The

Corcoran, A. J., Inc.

Dunk Tank Works

Eagle Tank Co.

Hauser-Stander Tank Co., The

Johnson &amp; Carlson

Kalamazoo Tank &amp; Silo Co.

National Tank &amp; Pipe Co.

Pacific Tank &amp; Pipe Co.

U. S. Wind Engine &amp; Pump Co.

Wendnagel Co.

## Temperature Regulators

Brown Instrument Co., The

Taylor Instrument Companies

## Testing Laboratories

See also Professional Directory, pages 378-377

## Testing Machines, Metal

Hols, Herman A.

Shore Instrument Co.

## Testing Sieves and Testing Sieve

Shakers

Multi-Metal Separating Screen Co.

Tyler, The W. S., Co.

## Thermit

Metal &amp; Thermit Corp.

## Thermocouples, Platinum

Brown Instrument Co., The

Hols, Herman A.

Pyroelectric Instrument Co.

## Thermometers

Bristol Co., The

Bausch &amp; Lomb Opt. Co.

Brown Instrument Co., The

Central Scientific Co.

Engelhard, Chas.

Foxboro Co.

Gaertner, Wm., &amp; Co.

Griebel Instrument Co.

Lens Apparatus Co.

Precision Thermometer &amp; Inst. Co.

Pyroelectric Instrument Co.

Schaeffer &amp; Budenburg Mfg. Co.

Taylor Instrument Companies

Thwing Instrument Co.

## Thermostat

Powers Regulator Co., The

Sarco Company, Inc.

## Thickeners (or Dewaterers)

Dorr Company, The

## Tiering Machines, Portable

Revolator Co.

## Titanium

Metal &amp; Thermit Corp.

Titanium Alloy Mfg. Co.

## Titanium Ores

Foote Mineral Co.

Titanium Alloy Mfg. Co.

## Tongs, Lifting

Lummus, The Walter E., Co.

## Tool Steel

Standard Alloys Co.

## Tower Packing, Acid Proof, Stoneware

Knight, Maurice A.

U. S. Stoneware Co.

## Towers, Acid

Acid Proof Iron Products Co.

Duriron Castings Co.

Kalberry Corp'n.

## Towers, Arids, Stoneware

The Acid Proof Clay Products Co.

General Ceramics Co.

Graham, C., Chem. Pot'y Wks.

Knight, Maurice A.

U. S. Stoneware Co.

## Tracks, Industrial and Portable

Easton Car &amp; Construction Co.

Lakewood Engineering Co.

## Transformers

Allis-Chalmers Mfg. Co.

American Transformer Co.

Kuhlman Electric Co., The

Transformers, Special &amp; Precipitation

Process

American Transformer Co.

Kuhlman Electric Co., The

Westinghouse Electric &amp; Mfg. Co.

## Transits

Ainsworth, Wm., &amp; Son

Traps, Steam &amp; Radiator

Sarco Company, Inc.

Standard Mechanical Equipment Co.

## Trolleys, I Beam

Brown Hoisting Machinery Co.

## Tubing, Seamless

Hough, W. S., Jr., Co.

## Tube Mills

See Mills, Ball, Pebble, Tube

## Tungsten Metal

Lavinio, E. J., &amp; Co.

Minerva Tungsten Corp.

New Jersey Zinc Company, The

## Tungsten Ores

American Metal Co., Ltd.

Continuous Reaction Co., The

Vanadium-Alloys Steel Co.

## Turbo Blowers

Ingersoll-Rand Company

Turntables, Industrial Railway

Easton Car &amp; Construction Co.

## Ultra Violet Ray Lamps

R. U. V. Company, The

## Uranium Alloys

Standards Alloys Co.

## Vacuum Drying Apparatus

See Dryers, Vacuum

## Vacuum Filters

See Filters, Vacuum

## Vacuum Pans

See Pans, Vacuum

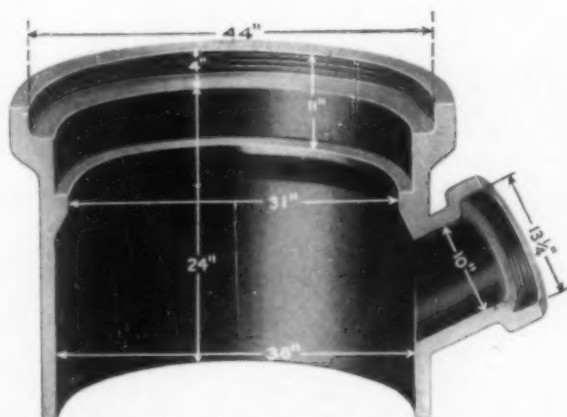
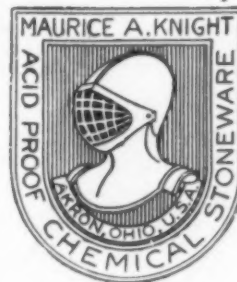




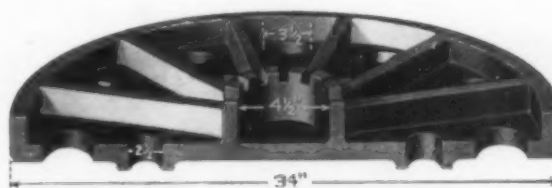
# It Is the Body Itself

Our clay and method of manufacture is NOT  
the same as used by others in our district

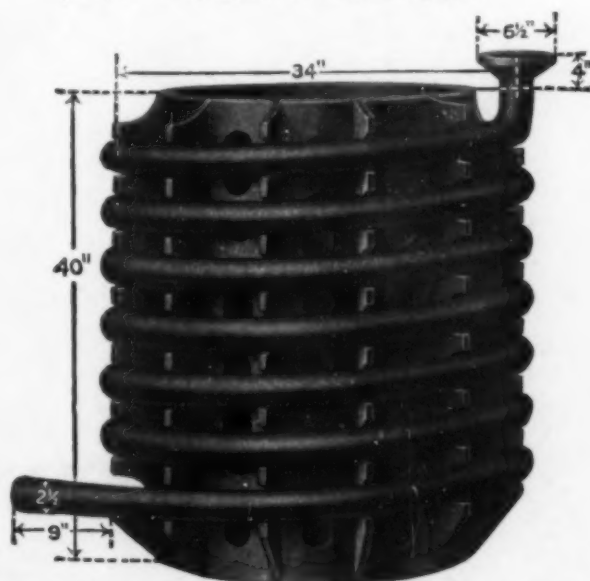
Our ware is NOT the cheapest, nor is it fancy, but it is GUARANTEED to be acid proof, free from defects, not to leak or sweat, and to be perfectly satisfactory in every respect.



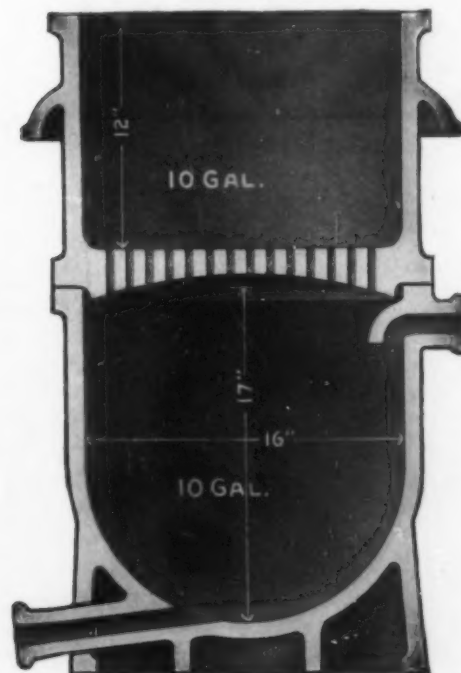
**ACID-PROOF TOWER BOTTOM SECTION**  
Showing 10" Y and Ring for supporting perforated plate, or as top section for distributing plate



**ACID-PROOF DISTRIBUTING PLATE**  
Made in many sizes and designs



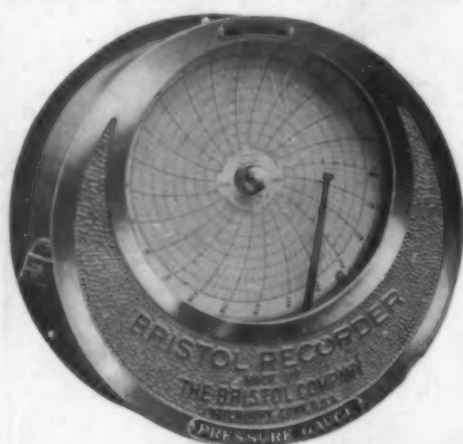
**STANDARD NO. 3—2" BORE VALENTINER COIL**  
We make coils or worms in any length or bore pipe



**ACID-PROOF SUCTION FILTER "A"**  
Made in most any capacity up to 100 gallons.  
Furnished with faucet and cover if desired

*Knight Acid - Proof Chemical Stoneware  
does not depend on glaze, enamel or veneer*

**MAURICE A. KNIGHT,** Office and Factory: **East Akron, Ohio**  
Kelly Avenue



## Bristol Recording Pressure Gauge

"Since we put in this recorder there have been days when it earned for us more than it cost."

TRADE MARK  
**BRISTOL'S**  
REG. U. S. PAT. OFFICE.

### Recording Thermometers

will enable you to keep a close check upon all temperature variations and the time at which they took place. By a glance at the chart any abnormal rise or fall can be known immediately.

The installation of these instruments increases efficiency of men and materials—hence increased output.



**THE BRISTOL COMPANY**

**Waterbury, Conn., U. S. A.**

Boston

New York

BRANCH OFFICES:

Pittsburgh

Chicago

San Francisco

# Are You Prepared?

CO<sub>2</sub> Recorder for Office of Chief Engineer. May be installed at any distance from the boilers and will trace continuous records of the changes in CO<sub>2</sub> and show these changes exactly as they occur during every second of operation.

The Period of Reconstruction will make extraordinary demands on us.

You will again enter World Competition.

Every instrument, every apparatus that makes for efficiency and economy becomes an imperative necessity to the progressive, farsighted manufacturer.

*Uehling CO<sub>2</sub> Equipment measures the sensible heat energy wasted up the chimney. It helps you to conserve fuel, lowers coal bills and makes for efficiency and prevention of waste in the power plant.*

The CO<sub>2</sub> Indicator at the Boiler Front guides the fireman, while the CO<sub>2</sub> Recorder in the office of the Chief Engineer furnishes a perpetual record of the fireman's performance.

**Uehling Instrument Co.**

Combustion Engineers

3025 Empire Bldg., New York

The Auxiliary CO<sub>2</sub> Indicator for the boiler front holds the fireman responsible for the record produced and is as essential to combustion economy as the water gage glass is to safety.

